SCIENCE

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THE BALTIMORE MEETING

The Baltimore meeting of the American Association for the Advancement of Science and the affiliated national scientific societies has never been equalled in size and importance by any gathering of scientific men in this country or indeed elsewhere. It might have been expected that the meetings held in the great centers of population last year and the year before would have set the high water mark of attendance for some years, but the registration at Baltimore was even larger than at New York or Chicago, and the percentage not registering was greater than ever before. Registration can only be regarded as a habit or duty, as it confers no privilege, the list not even being printed. Of the 300 chemists at the New York meeting only 106 registered; at Baltimore, where the chemists met in a distant part of the city with an attendance of about 400, perhaps not more than 50 registered. The actual registration of members of the association was 1088; the attendance at the meeting can only be guessed, but it may have been in excess of 2,500.

Size is not in itself significant; it may be an advantage or it may be a nuisance. But in so far as the growth of the convocation week meetings means an increased number of scientific workers in this country and a willingness on their part to cooperate, it is grati-

fying and important. A very large meeting has for those in attendance certain advantages and certain disadvantages. It is irritating not to be able to attend the conflicting meetings of nearly equal interest and not to be able to converse at leisure with friends and acquaintances. It should, however, be remembered that if the different societies were meeting in different cities, it would be still less possible to attend the meetings that one would like to attend and to see the friends that one would like to see. It might be possible for the sciences devoted to the biological sciences to meet in one city and for the sciences devoted to the physical sciences to meet elsewhere; perhaps for the geologists and the philosophers to meet by themselves. But in such a case what are the biological chemists, the biometricians, the students of evolution, the cosmical physicists, the geographers, the psychologists, etc., to do?

The real conflict is not between the chemists and the zoologists, for example, but within the single science. Thus at Baltimore the Zoological Society of America and the zoological section of the association each had some sixty papers on its program; there were two entomological societies and a society of vertebrate paleontologists in session, the psychologists had a morning devoted to animal intelligence, etc. It is not possible to read and discuss consecutively three hundred papers. The best that can be done is to have sessions of interest to all scientific men, to all biologists, to all zoologists, and then to divide zoology into sections for the reading and discussion of special papers in different departments. The chemists, whose numbers are the largest, have naturally led the way in organization. They have well-organized sections throughout the country for frequent local meetings; they have a summer meeting, usually by themselves, and meet with the other societies in convocation week; they have certain general meetings and then divide into numerous sections; all the papers in chemistry are referred to the American Chemical Society which organizes the joint program.

We may look back with certain regrets to the "good old days" when there were so few workers in each science that they could all be acquainted with one another and with one another's work, or still further back to the age of academies when all the scientific men of a city or county could meet together with common interests; but no one imagines that we can go back to these days, or that it would be desirable to do so. It is like the man who has acquired wealth and power and thinks of past days when life was less complicated and perhaps happier.

> Haply, the river of Time—
> As it grows, as the towns on its marge
> Fling their wavering lights
> On a wider, statelier stream—
> May acquire, if not the calm
> Of its early mountainous shore,
> Yet a solemn peace of its own.

It is of course true that the problems of scientific organization are by no means solved. Some of them may be settled in a satisfactory manner; others may be quite unsolvable. There were at the present meeting needless mistakes on the program,

such as announcing the wrong building for the address of the president and the wrong afternoon for the meeting of the Naturalists; needless dispersion, as in sending the sections of anthropology and of education to large auditoriums at a distance when the lecture rooms of the university would have held and secured larger audiences than were present; needless conflicts, as the programs of the Zoological Society and the Section of Zoology in adjacent rooms. There should be one man thoroughly familiar with the situation and competent to do the best that can be done under the circumstances. We need a secretary of science for the country, not less influential and not less well paid than the secretary of the Smithsonian Institution, who will devote his whole time to the organization of science and of scientific men.

It is quite possible that it would be better to have a convocation week meeting only on alternate years, or even less often, leaving the societies to scatter in intervening years. Or it might be better to divide the association into sections for the eastern, central and western states and hold a joint meeting once in three or in five years. Again it might be well to have an association devoted to the diffusion and popularization of science, separate from an affiliation of the scientific societies composed of professional scientific men. At present the association fails chiefly in the former function. It has a considerable membership in addition to the scientific workers of the country, and there were many sessions at Baltimore that would have been interesting and useful to them, but practically none were present. The association also fails to exert an influence on the general public through the press.

But in spite of difficulties and partial failures, the convocation week meetings have since their establishment in Washington six years ago performed a great service for science and for scientific men. They lead men of science to recognize the community of interest that should obtain; they impress on the general public the weight and magnitude of science; the council, representing the scientific interests of the country, may become an important factor in their advancement. The members of the association, all of whom have the privilege, or at least the opportunity, of reading this journal, have increased from 1,721 in 1899 to over 7,500. All this represents a coordination that may be used effectively for the advancement of science; and whatever forwards the advancement of science is for the benefit of every one.

An account of the business transacted by the council representing the association and the affiliated societies will be given in the report of the general secretary, and this will be followed by accounts of the proceedings of the several sections and of the different societies and by some of the more important addresses, papers and discussions.

The association was fortunate in being welcomed to the Johns Hopkins University and to Baltimore by two of its distinguished recent presidents, and in having as president of the meeting one of the world's most eminent geologists whose

public services extend far beyond the bounds of his science. The admirable address of the retiring president, printed last week in SCIENCE, deserves to be read by every intelligent citizen. It is unfortunate that our daily papers will not follow the example set in Great Britain and print in full an address of this character. Several of the vice-presidential addresses before the sections of the association and several of the presidential addresses before the special societies were of great general interest, while others equally important were technical in character. It would perhaps be desirable if the vice-presidential addresses were always addressed to an intelligent audience rather than to specialists, or at all events if the program would indicate the class for whom each is intended. Among the interesting public lectures may be noted the following: Professor Poulton, of Oxford, on "Mimicry in the butterflies of North America"; Professor Penck, of Berlin, on "Man, climate and soil"; Professor Münsterberg, of Harvard, on "The problem of beauty"; Mr. Bryan, of Honolulu, on "A visit to Mount Kilauea"; Major Squier, U.S.A., on "Recent progress in aeronautics," and Mr. G. K. Gilbert, of the U. S. Geological Survey, on "Earthquake forecasts."

It seems to be scarcely credible, but it is the case, that there were on the program published by the association the titles of more than one thousand papers to be read at the meeting. The great majority of the papers represent research work of a high order. It is sometimes said that the United States is not doing its part in the advancement of science, but this program is a conclusive answer to such criticism. No other country except Germany could hold a meeting in which so many scientific researches maintaining such high standards could be presented as the result of a year's work, and Germany has never held such a meeting.

These papers were in the main special and technical in character, but there were in each science papers containing results of interest to a wide group of scientific men, and in many cases papers and discussions of broad interest to the general public. Among these were the series of addresses before the American Chemical Society, the symposium on correlation in which sixteen leading geologists took part, three general discussions arranged by the botanists, the symposia on college education and life, on physical instruction in schools and colleges, and on public health. Most important of all—perhaps the most significant scientific celebration hitherto held in this country—was the Darwin centenary memorial. Professor E. B. Poulton, the leading exponent of natural selection, came from England to take part, and after his address a series of papers was presented by our leading workers in problems bearing on evolution. The day's proceedings closed with a dinner, at which speeches were made by President Chamberlin, Professor Osborn, Professor Welch, Professor Penck and Professor Poulton.

The meeting next year will be held at Boston under the presidency of Dr. David

Starr Jordan, president of Stanford University. It was recommended that the following meeting be held in Minneapolis. All the affiliated societies will probably wish to go to Boston, and the meeting is likely to surpass in importance even the present meeting. In the following year the special societies whose membership is chiefly on the Atlantic seaboard will have an opportunity to meet separately. In order that the societies may have information in planning joint or separate meetings, the general committee voted that it looked with favor on convocation week meetings in Washington, Cleveland and Toronto, following those in Boston and Minneapolis. The council of the British Association has invited members of the association to attend the Winnipeg meeting next August, the officers as honorary members. In the following summer a meeting will probably be held in Honolulu.

SCIENCE TEACHING AS A CAREER[1]

It is scarcely a serious exaggeration to say that the first thought regarding a teacher which comes to the minds of many estimable people is that of a person who, by virtue of a greater or less assumption of knowledge, is able to occupy a position in which he has frequent long vacations, and in the interim draws a comfortable salary for comparatively short working hours. Such, at least, is the conclusion which may apparently be drawn from the frequency with which these topics are introduced into conversations incident especially to the making of new acquaintances. But these same persons would many times experience a tinge of regret if their sons should choose to adopt this career, and that not because they definitely believe it to be an unworthy or inadequate career, but because they understand very little about it. It is, however, not only true that this supposedly comfortable profession is not overcrowded, but there is evidence that there is a positive dearth of able young men who have both the aptitude and disposition to become teachers. It seems to me, therefore, fitting that we who are interested in the advancement of science should spend a few minutes in the consideration of the conditions which confront a young man who is disposed to become a teacher of science, since the maintenance of a corps of competent teachers is of no less interest to us all, practitioners as well as pedagogues, than are the subjects which they should teach, some of which have been ably discussed in recent addresses.

It is the more appropriate that this question should be considered at this time, since certain presumably authoritative data regarding the compensation of teachers have recently become available, and because the establishment of a section on Chemical Education on the part of the American Chemical Society, the first session of which follows this address, indicates an awakening interest in all that pertains to the education of the chemist and chemical engineer, among which the question of the best means to maintain our supply of capable teachers must assume an important place.

What I shall say will apply doubtless most closely to teachers of chemical science in institutions of college grade, because the conditions under which they labor are most familiar to me; but much that may be said of these teachers is true of those in other sciences which stand in a relation to the arts similar to that of chemistry. A

[1] Address delivered by the retiring chairman of Section C of the American Association for the Advancement of Science, at Baltimore, December, 1908.

great deal has been written on this and similar topics, and I can claim very little originality in the thoughts which follow. I present them in the hope that they may arouse in you, parents, employers, practitioners and teachers, an increased interest in the general welfare of those to whom the teaching of science is entrusted.

It may first be asked, What ground exists for the assumption that there is a present or prospective lack of science teachers? It seems to me that this is indicated by the increasing difficulty which is reported from various institutions and from various departments as having been experienced in filling their instructing corps with the best type of men. I know this to be true in chemistry from my own experience, and from the marked increase in the number of applications for assistants which have come to me from all parts of the country. Unless many of us misjudge the trend of the times, the increasing pressure of competition, making necessary the improvement of old and the devising of new means for the utilization of by-products and waste materials, the greater refinement of products without added cost, demanded by the consumer, and the awakening of the country to the necessity of husbanding its natural resources, all tend to place the chemist and chemical engineer in the forefront of industrial activity, and to make those professions increasingly attractive to our young men, as affording unexcelled opportunities for productive work in a field which at present is not overcrowded. If, at the same time, it is possible by missionary effort to dispel the well-established notion among fond parents that chemistry, pure or applied, is synonymous with explosions and impaired health—an opinion which lacks a statistical basis—the number of young men entering the profession will doubtless increase, but it may fairly be questioned whether what may be designated as the "call of the practical" will not prove increasingly alluring, and our difficulties in retaining able men of the type which we desire to enlist in the service of our institutions, become more and more serious.

Let us face this situation squarely and ask, What is it that makes this "call of the practical" so enticing to ambitious, thoughtful young men who are conscious of their ability to get results, or, perhaps, merely hopeful of a fair measure of success in what they undertake? Money and opportunity are obviously the influential factors; and in the best type of men the latter is likely to be given the greater weight in the selection of a life work. Let us look at these a bit more closely. No one acquainted with existing conditions, if appealed to for advice by a young man facing his choice of a career, would fail to point out to him the probable financial sacrifice involved in the selection of the work of a teacher. Indeed, this is so serious a question that in the case of a young man who may be without financial resources other than his earnings, but is tactful in his dealings with his fellowmen, of high scholarship, and with ability to think independently—just the man who is needed in our corps of teachers—one may well pause before uttering decisive words of counsel which will almost certainly be of great influence in determining the material prosperity of his later life; of greater influence, I sometimes fear, than our knowledge of the past or our prescience really warrants.

How great, in reality, is the financial sacrifice involved in a decision to enter the teaching profession? Data regarding the compensation of teachers in institutions of college grade have recently been made public by the Carnegie Foundation for the Advancement of Teaching in its Bulletin Number Two, on "The Financial Status of

the Professor in America and Germany." In view of the unusual opportunity possessed by the Foundation for the gathering of authoritative data, the figures presented merit attention. No distinctions are made between teachers of science and those in other departments, but, considering salaries only, it does not appear that marked differences exist, and it is probable that the average salaries as there given may be taken as being also representative of those of science teachers. Some of the more relevant statements are as follows: Considering one hundred and three institutions in the United States and Canada which have an annual salary budget of \$45,000 and over, the average salary of a full professorship ranges from \$1,350 to \$4,788. Only eight institutions report an average below \$1,800, and only nine an average above \$3,500. Half of these institutions average less than \$2,200. Taking them all into account, the average appears to be close to \$2,500, but there are more below than above this figure. Individual salaries apparently vary from about \$500 to \$8,000, both being, however, exceptional.

The average salary of an assistant professor is about \$1,600 (half of the institutions pay less than \$1,500); and the salary for the grade of instructor averages a little over \$1,000.

Closely linked with the amount of the salaries paid is the question of the period in the teacher's life when the various amounts may be expected to be obtainable. On this point the statement in the bulletin, based on the available data, is this:

> A man acceptable to these institutions for a position worth \$1,250 will be on an average 28 years old; a man appointed to a position worth \$1,750 will be on an average 31 years old when appointed to it; one appointed to a position worth \$2,250 will be on an average 33 years old; one appointed to a position worth \$2,500 or over will be on an average 34 years old.

And elsewhere it is stated that appointments to positions carrying salaries of \$3,000 and upward are not usually made before at least 35 to 39 years of life have been completed.

It is interesting to note in passing that the data from fifty-four additional institutions having salary budgets below \$45,000 annually, indicate that the average salary of a full professorship in them is \$1,800, and that this is reached by men when about 33 years of age.

The average salary of an assistant approximates \$500. It is, however, properly emphasized that the period of service as assistant is essentially one of apprenticeship, during which the incumbent gains much more than is represented by the monthly salary check. Indeed, it is my own conviction that a year of service of this character is, to a right-minded young man, nearly the equivalent of a year of post-graduate study, and affords an experience which is valuable, whether the career ultimately chosen is that of a teacher, or lies in the commercial field.

In order to determine whether, or by approximately how much, the teacher is at a disadvantage as compared with others of equal age and training in other occupations, information was collected by the Carnegie Foundation which is to the effect that the average competent lawyer and competent engineer, after being out of the professional school about eight or ten years (thus approximating the age at which a full professorship with an average salary of \$2,500 is attained) would be earning in New York between four and five thousand dollars a year. A physician might earn somewhat more. The average professor's salary at Columbia University is \$4,289, while that of the College of the City of New York is \$4,788; but, for special reasons, these averages are said to be abnormal. The corresponding figure for Stevens Institute

of Technology is $3,200, and that for Brooklyn Polytechnic Institute is $2,783. It appears, then, that the average college professor at 34 is receiving a less return than his contemporary in other professions by perhaps $1,000 per year, although there may well be individual instances in which there is little disparity. But this is not the main issue; for, as is pointed out in the bulletin referred to, it is at this point that the divergence in the financial rewards begins to increase rapidly. The salary of the full professorship, reached at 34, represents nearly the limit of the earning power of the encumbent if, as is so often true in our institutions, his entire energies are consumed in his institutional service, unless perchance he occupies some position carrying with it special administrative responsibilities. His colleague without the walls of the college has, on the other hand, also just entered upon his most productive period, and may reasonably hope to see his income increase into the tens of thousands, permitting him to maintain a comfortable home and affording him means to meet the growing expenses incident to the education of his children. So far, then, as young men are influenced by the maximum financial rewards and prizes attainable, it must frankly be admitted that, at present, the teaching profession is at a disadvantage.

But I am personally disposed to believe that such difficulties as exist in securing and holding able men as teachers of science are less the result of the comparatively small maximum returns which may be expected when the final stage in professional promotion has been reached, than because of the depressing conditions which confront them during the long period which now elapses between the attainment of salaries of $800 to $1,000, and a salary of $2,000, a period which, in the larger institutions is probably rather more than six years. The young teacher's apprenticeship as assistant or junior instructor is over, and he is anxious to feel that his long period of study and development is bringing him an adequate return, and he hears his classmates tell of bridges built, factories started, laurels won, and salaries raised—sometimes with an all-too-thinly veiled suggestion that he has chosen the less worthy rôle—and he longs to join those who can boast of material successes. To this is often added the proper desire for a home of his own. Or perhaps the home has been established, when there must be a struggle to provide those comforts (not luxuries in an extravagant sense), which his temperament and training lead him to desire, which his institution and his community tacitly expect of him, and which above all, would make of him a man of growing refinement such as we are increasingly in need of in our teaching ranks. Helpful and necessary as it is to increase the salaries of the higher paid professional positions as soon as this is possible, I believe that there is a still more urgent need that the salaries of the junior grades should be earlier lifted to a point at which the strain of anxiety is removed and moderate comfort and congenial surroundings are made possible. This is, of course, mainly true of our larger institutions, or those situated in communities where the cost of living is now so sadly out of proportion to the amounts on the salary lists, but it may be questioned whether the ratio of income to outgo is essentially better in smaller institutions and places. I believe that this is a matter which all of the college authorities should consider in order that this period may prove less repellent and that the rounding out of the nonprofessional side of the science teacher, which is often so large a factor in his success, may not be postponed until many of his best years have been spent in a de-

pressing effort to accomplish the impossible. A young teacher is fortunate if, during this time, he is not obliged to suppress his desire for research, acquired by years of training, in order to avail himself of opportunities to add something to his meager income.

Data concerning the salaraies paid to teachers of science in public schools below college grade are to be found in the Report of the Committee of the National Educational Association on Salaries, Tenure and Pensions of Public School Teachers in the United States, dated July, 1905. From the extensive tables there given it would appear that the average maximum salary paid to male teachers in cities or towns having from 8,000 to 12,000 inhabitants is about $800 per year, in cities numbering 10,000 to 15,000 about $1,000, in those of 15,000 to 30,000 population about $1,200, in cities of 30,000 to 75,000 inhabitants about $1,500, and so on up to cities of 200,000 inhabitants or over, when the maximum is about $2,000. The highest salaries are paid in New York, amounting probably to $3,500 for those having positions of sub-masters or heads of departments. The opinion has been expressed to me by well-informed science teachers that the salaries paid such teachers do not differ essentially from the average salaries named above, but that salaries paid by private schools may be in general somewhat higher than the figures named. Here, again, it seems to me that those in authority should realize that more than a bare living wage must be provided for the younger teachers if the best results are to be obtained, and my own observations lead me to express a further belief that the efficiency of these teachers is much less than it might well be because of inadequate assistance—a condition of affairs which makes it necessary for them to devote time which should be spent in instruction to the mere distribution of supplies. It is expected that these and other related topics will be considered in detail at some early session of the Education Section of the American Chemical Society. I will not, therefore, dwell longer upon them now.

It has already been said that the opportunity for accomplishment which the technical field opens before the young man is alluring to a high degree, and, although I have thought it wise to dwell first upon the financial aspects of a teacher's career, I am far from thinking that the avoidance or abandonment of that career by those who have shown themselves fitted to enter upon it, is mainly due to anything which could be described as greed or avarice. What, indeed, can be better worth undertaking than the development of a new industrial process, very likely the product of one's own careful thought; to watch it grow from a thing of the beaker and test-tube in the laboratory to the successful operating plant, where tons are substituted for grams? Where are there problems better worth attacking than the careful investigation of sources of difficulty in existing processes, with the sense of satisfaction and triumph which accompanies their ultimate rejuvenation? And to whom does there come wider opportunity for honorable service and tangible reward than to one who, through leadership and the helpful guidance of a corps of trained investigators such as are found in the research laboratories of some of our larger manufacturing organizations, has at once the privilege of extending the boundaries of his chosen science and, by improving or cheapening production, to increase industrial efficiency, which in many instances means ultimate benefit for us all. The joy of material accomplishment belongs to the worker in each of these fields.

What is there, then, left to be said in behalf of science teaching as a career? Very much; almost everything indeed, if

we are speaking to the man whose aptitude lies in that field. Let us turn again for a moment to its bug-bear, the financial side, which will then be finally dismissed. Conditions are not just as we, the teachers, or the college authorities, would desire them to be, but there are signs of improvement, which this Association and the Chemical Society can promote. But after all, the teacher's patience is ultimately rewarded by a monetary return which for the really able man (who alone would receive the higher rewards in the commercial field) is not inconsiderable. Moreover, his tenure of office is in general secure during good behavior, and it is no small comfort to feel that the salary check, though of moderate amount, will appear regularly during those times of stress when our supposedly more fortunate brothers are growing grey with anxiety regarding the next turn of the market.

The science teacher of to-day is, moreover, usually something of a specialist and expert, and I believe that it is his duty, as well as his privilege, to make himself acquainted with the applications of his specialized knowledge in the technical field, and so far as it may be done without violence to duties already assumed, to avail himself of opportunities for expert service, especially where these involve an impartial treatment of problems of some importance. Service of this sort well-performed is highly remunerative, and serves at once to broaden the teacher and to contribute to the comfort of those dependent upon him; and in individual instances, to relieve much of the disparity between the income of the teacher and the technicist. In this respect the science teacher possesses a distinct advantage over his brother in the academic field, and the engineer or chemist an advantage over the specialist in a descriptive science, such as astronomy.

The effect of the establishment of the Carnegie Foundation for the Advancement of Teaching must not be overlooked. Its generous endowment provides, as many of you know, retiring pensions which may be claimed as of right by teachers who have served in a professorial capacity for twenty-five years, or who have reached the age of sixty-five, with a record of fifteen years of professorial work. Provision is also made for the family of a teacher who at the time of his death was entitled to a pension. It may, however, be noted that at present no general provision is made for the same class of junior professors referred to above as struggling with meager salaries. It would undoubtedly prove exceedingly helpful, both by relieving anxiety and by making the teaching profession more attractive, if it were ultimately found practicable to provide widows' pensions in the case of the death of junior teachers who have not completed the prescribed twenty-five years of service. It is apparently true, however, that the trustees of the Foundation would even now consider individual cases of need, on their merits.

But what of the opportunities, the privileges of the teacher? They are almost limitless. Is there drudgery? Yes; but what vocation is without it? Does he have to repeat the same story year after year? In part, yes; but it never need be wholly the same and the audience is never twice the same. And the long vacations? They are available, if they are needed (and then they are blessed indeed), but they are seldom periods of continuous idleness, but are rather one of the great opportunities which come to the teacher, as to few others who are under obligations to render definite services. To the progressive, enthusiastic teacher these should be periods of growth; a chance for uninterrupted thought regarding his specialty or his work; a chance

to record his thoughts for the benefit of others, if he is so minded; a chance for research work, or, perhaps, a chance to follow some hobby or to travel. In short, these vacation days bring with them a necessary relief from the exhaustion attendant upon a constant effort to adapt oneself to the needs of those about him, which, as we shall see, is a necessary part of a teacher's life, and they afford him an opportunity for freedom of choice in his pursuits which is often prized quite as much in connection with his avocation as with his vocation. But this freedom of choice is not confined to vacation days. It constitutes one of the great attractions of the teacher's life. Not only may he choose freely within his specialty in selecting a congenial subject for investigation, thought or exposition, but he may even change his specialty and qualify as an expert in a new field without loss of prestige, and often without financial inconvenience. With the recognition of the fact that a teacher accomplishes most when allowed to inject his individuality into his methods of instruction, wise administrators will try to exercise control over the individual only so far as is absolutely necessary to preserve general unity of purpose and policy in a given institution, holding each teacher responsible for results in his own classes. With this freedom to select his own methods, it is hardly possible that the work of a thoughtful teacher should become irksome because of repetition, especially when it is remembered that his pupils present an infinite variety of types, each type with its own personal equation to be studied. The fact that wholly ideal conditions as to "academic freedom"—whatever that may mean—have not yet been reached is, I think, not a reason for depression on the part of the teacher, and is still less a cause for hesitation on the part of one desiring to enter the profession. There is to-day surely at least as great freedom as in any other profession with equal obligations; and the outlook for the future is hopeful.

Some young men are, I believe, deterred from considering teaching as a profession because they regard the teacher as an essentially unpractical man—a man who is, to be sure, generally respected for what he is supposed to know, and is accorded social recognition, but who, nevertheless, may, in clothing himself for his daily tasks find difficulty in distinguishing his right shoe from his left, or may appear on the most formal social occasion without some essential article of wearing apparel, because of mental preoccupation. Such men exist, but they are typical of a limited number of teachers only. They are, as a rule, investigators and intense specialists who should gather around themselves a group of advanced students sufficiently mature to largely forget personal peculiarities in the enthusiasm which they have for the work in hand. The rank and file of teachers are not such as these, and it is well that this is so.

It is recognized that every earnest teacher should either carry on some research work of his own, or be able to be in contact with those who are conducting such work, in order to keep himself acquainted with the progress of his science, and here, again, he may choose between an abstract problem in science and one with utilitarian bearings. He should not, in my opinion, lose caste to any degree if he chooses the latter, provided the problem is worthy of the time and energy which its solution demands. Every teacher should thus be something of an investigator, but not every gifted investigator should, in my opinion, be entrusted with the care of undergraduate instruction. By this I mean that the teacher, as is pointed out in Professor George H.

Palmer's admirable essay on "The Ideal Teacher," must be primarily one who has an aptitude and a passion for making scholars of others, rather than merely becoming one himself. Many learned men think too rapidly and keenly to be able to adapt themselves to the younger students. Professor Palmer justly puts "the aptitude for vicariousness" first in his characteristics of the ideal teacher, for it is only by constantly putting oneself in the place of the "average man" of the class that the teacher can evolve genuinely helpful methods of presentation, and enable his students to take such possession of the knowledge imparted that it adds to their power rather than to their collection of impedimenta. The teacher must not only, as some one has aptly said, have his knowledge in "contagious form," but he must study methods for spreading the contagion; for the sterilizing outfit on the side of the student is all too often wonderfully efficient in its working.

I desire to give expression to a conviction that some influence—whether the increased pressure of the times in which we live, or the alleged materialistic tendencies of these times, or the increased absorption of the science teacher in his specialty, it is difficult to determine—some influence, I say—seems to be operating to diminish the interest on the part of younger teachers of science in breadth of culture. In technical institutions particularly, it is vital to the best results that the younger students especially should be made to appreciate that even the grade of professional position which they will ultimately fill will depend upon their ability to view their own profession broadly, upon their ability to take their proper part in community life, and upon their ability to have an avocation which will relieve the tension of uninterrupted and often anxious thought along one line. Mere preaching will not accomplish this end; but men who are themselves real examples of the enrichment which comes into life from breadth of interests can by simple contact do an untold amount of good—and that, too, when they themselves least suspect it. We need more men of this type, and I believe we can get more when it is possible to improve the living conditions of the junior members of the instructing staff, so that there is somewhat more time for that personal development which is too often postponed now, because of the exigencies of the early years of teaching.

And now we come to the crowning joy of the teacher, the joy of helpfulness. Fortunately, he may often also experience the delights of conquest known to the investigator; but, as a teacher, his keenest satisfaction must be found in the contact with young men, and in the consciousness that his efforts have made some dark places less confusing and obscure, and that life is to have more and a better meaning for some men because of his association with them. He must, as Professor Palmer points out, "be willing to be forgotten," in that he must not set a desire for popular approval in the place of real helpfulness, and, unless he courts disappointments, he must not expect an expression of gratitude or even of appreciation on the part of the few who take any notice of him which is in any way commensurate with the effort which he knows that he has put out in their behalf. But the sympathetic, helpful, well-informed teacher may expect to make warm and lasting friends in a larger measure than almost any one else. I believe that any teacher, whether of junior, senior or advanced students, who does not so far gain the good will of his pupils that they feel that his relation to each is in some measure personal rather than merely professional,

falls short of the best attainable. The scholarly teacher, with the genuine passion for making scholars, is fortunate indeed if he combines with it such broad sympathy and good sense that his pupils will come to him for advice on homely, everyday questions; for the influence thus gained doubtless reaches farther than we can possibly know. For the teacher of science, who more than his colleagues in other departments of learning, has the opportunity to lead the thoughts of his pupils by an occasional judicious word toward a better appreciation of the orderliness of that which we do know, and of the vastness of that which is beyond our ken, the privileges as well as the responsibilities are especially great.

The teacher's career is one of some sacrifice. Let us admit it, and admit also that it may not be undertaken by those who have not aptitude and liking for it, for these are both indispensable to success. But let us remember, too, that it is truly a noble calling, accorded a dignified standing in our communities; that it means for those who enter upon it an association with scholars and a share in those affairs which we believe make for advancement of our race; that its rewards in the way of recognition among scholars, and in the occasional spontaneous expressions of appreciation on the part of pupils, as well as in the lasting friendships formed, are not unworthy to be placed beside the more striking and tangible financial successes of other professions. Let us recall that the advancement of our sciences must always depend in a large measure upon the maintenance of a high type of teacher, as well as of teaching, for which we need able, broad-minded men, not those who are merely indisposed to adopt some other profession; and to this end let us foster an interest in the teacher's career on the part of more of those to whom those traits of mind and character which make for success in this honorable profession have been freely given.

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RECENT RESEARCHES ON THE DETERMINATION AND HEREDITY OF SEX[1]

I. STATEMENT OF THE PROBLEM

DESPITE certain technical difficulties, the subject of sex-production has seemed to me to be an appropriate theme for this occasion for two reasons. The phenomenon of sex is so nearly a universal one that it may be assumed to make some appeal to the interest of biologists in every field of inquiry. Secondly, although the physiological meaning of sex still remains in many respects enigmatical, it may fairly be said that substantial advances in the analysis of the mechanism of sex-production are being made by experimental and cytological research. It is not my intention to consider at this time the possible significance of sexual reproduction or the physiological and cytological problems involved in the phenomena of fertilization. My discussion will be confined mainly to the more recent of the researches that have thrown light on the questions of sex-determination and sex-heredity. Does sex arise, as was so long believed, as a response of the developing organism to external stimuli? Or is it automatically ordered by internal factors, and if so, what is their nature?

It will be well at the outset to remove any possible obscurity from our definition of the problem. Every form of heredity —and sex-production, broadly speaking, is unquestionably a phenomenon of heredity —is in one sense a response of the developing organism to external stimuli. The

[1] Address of the vice-president and chairman of Section F—Zoology—of the American Association for the Advancement of Science, Baltimore, 1908.

characteristic mode of development of the organism (which is only another way of saying its heredity) is as definitely conditioned by its environment as by those internal agencies that we ascribe to the specific organization of the germ. The end result is a product of internal and external factors acting together. But the distinction I have drawn is nevertheless perfectly real and definite, as will perhaps appear more clearly if the inquiry is stated in the following way:

1. Is the germ originally of indeterminate sex, or sexless, being determined as male or female at some later period by corresponding differences of conditions external to the germ? Or,

2. Given an identity of external conditions in each case, is the germ predetermined from the beginning as male, female or hermaphrodite by internal factors of its organization? And

3. If such predetermination exists, what is its physical basis?

These questions can not be adequately considered without some preliminary examination of the sexual distinction in general. We use the words "male" and "female" in a double sense. In the original and still common one they denote certain characteristics of the individual body, primarily those shown in the reproductive organs, secondarily those of other organs. Later the same terms were often applied to the germ-cells themselves, the eggs being spoken of as the "female germ-cells," the spermatozoa as the "male"; and this usage is often met with at the present time, even in technical treatises. But confusion thus at once arises; for, as we shall see, there are many cases in which the eggs or the spermatozoa are themselves of two classes which are respectively male-producing and female-producing, and have accordingly been spoken of as "male" and "female." It is therefore preferable, at least in case of the higher organisms, to designate the gametes as paternal and maternal, restricting the words male and female to the body by which they are produced. In the case of unicellular forms, where every cell may be potentially or actually a gamete, it is doubtful whether the words male and female should be used at all. In the isogamous forms, some of which occur among the lower multicellular types, the gametes are of equal size and similar structure, so that every visible sexual distinction may vanish. But even here the gametes are in some cases known to be of two physiological classes (as in certain simple algæ and fungi) each of which unites only with the other. A primitive form of sexuality is therefore present, but the gametes and the individuals that produce them can only be designated by non-committal terms such as "plus" and "minus" (Blakeslee).

Even in the higher plants and animals caution is necessary in our use of terms. Primarily we designate as males and females individuals that produce respectively spermatozoa and eggs, or their analogues; and as hermaphrodites those that produce both kinds of gametes. In the flowering plants confusion arises from the transference of these terms by analogy to the non-sexual generation or sporophyte; and a species may be hermaphrodite or monecious in respect to this generation and diecious in respect to the sexual generation or gametophyte. But whether in this sense or in the original one the sex-distinctions are not fixed or absolute. Not infrequently in hermaphrodites the production of eggs and of spermatozoa takes place at different times, so that the organism passes through a functional male stage and a functional female one. Conversely, it is a familiar fact that the sexual characters of diecious forms are seldom completely separate. Each sex frequently

exhibits in a more or less rudimentary form characters that are fully developed and functional only in the opposite sex. In exceptional cases these structures may become fully developed or even functional, as we see in the occasional appearance of functional mammary glands in the male mammal, or of fully formed stamens in a female flower; while true hermaphrodites occasionally appear, even in diecious species. This suggests that "male" and "female" are but relative terms that denote tendencies more or less pronounced but not absolutely separate or distinct. The male or female has accordingly often been regarded as a potential hermaphrodite in which one sexual tendency dominates more or less completely over the other; though, as will be seen, there is reason to regard the distinction between hermaphrodite and diecious organisms as more fundamental than this. The sexual individual is thus in some respects comparable to a Mendelian hybrid; and a number of eminent students of the subject have endeavored to show that it actually is such a hybrid.

The past decade has witnessed a remarkable change of front in regard to the general problem. Even in very early times it was suspected that sex might be controlled by internal factors; and such has long been known to be probable in case of the honey-bee, where, if the Dzierzon theory be correct, the fertilized eggs produce only females, the unfertilized eggs, males. Until recently, nevertheless, opinion has been largely dominated by the view that sex-production is in general controlled by extrinsic conditions. A large number of the earlier researches, and some of the later ones, have in fact seemed to show that sex is thus determined. There is no manner of doubt that sex-production may be affected by such conditions, and that its operation may thus be in some cases artificially altered. A classical example of this is the fact, shown by the researches of Prandtl, Buchtien, Klebs and others, that alterations in the conditions of nutrition or of light may determine the production of the male and female organs in fern prothallia; and analogous effects of changed external conditions have been produced in case of Hydra. But these are not properly cases of sex-determination, but rather of the suppression or retardation of one set of sexual organs in favor of the other in hermaphrodites; and they are not to be directly compared to a change of sex in the true diecious forms. Again, it has long been known that the production of males in the aphids is definitely affected by external conditions, and more recent experiments show that the same is true of the daphnids. But here again we are not dealing with a change of sex in the individual. These effects involve a change from parthenogenetic generations that produce only females to those that produce sexual females and males. The same is true of Maupas's well-known results on the rotifer *Hydatina* (though these have been disputed). As far as ordinary diecious forms are concerned most of the recent experimental work, such as that of Strasburger on the flowering plants, of the Marchals on diecious mosses, of Schultze and Cuénot on mammals, insects, amphibia and other animals, has led to purely negative results, and seems to show that from the fertilized egg onward the sex of the individual is unalterable by external conditions.

II. Sexual Predetermination and Predestination in the Germ-Cells

The whole mass of statistical and experimental data on this question is placed in a new light by the proof, recently brought forward, that in many organisms the fertilized egg or zygote is already prede-

termined as male, female or hermaphrodite; while very many of the earlier experimental data have either failed of confirmation or have been shown to be susceptible of a different interpretation from that first assigned to them. Cytological and experimental research combine to show, not only that sex is predetermined in the zygote, but also that it is in many cases *predestined* (I do not here say predetermined) in the gametes or even much earlier. It is a familiar fact that in some of the higher pteridophytes sex is predestined in the microspores and megaspores which produce, respectively, male and female prothallia; and the same is, of course, true of their homologues in the flowering plants. It has likewise long been known that in a few cases sex is similarly predestined in eggs of two sizes in the animals, for instance in *Hydatina, Phylloxera* and *Dinophilus apatris.* But even in cases where the germ-cells appear quite alike to the eye it has been shown that a sexual predestination may exist. A primitive but perfectly definite predestination of this kind has, for instance, been proved by Blakeslee to exist in both the zygotes and the asexual spores of various species of fungi; and a similar predestination has been demonstrated also in some of the more highly differentiated types, such as the mosses and liverworts. As an example of this I select the recent beautiful studies of the Marchals on the diecious mosses. Isolation cultures prove that the asexual spores, though similar in appearance, are individually predestined as male-producing and female-producing; and all efforts to alter this predestination by changes in the conditions of nutrition, such as are known to be effective in the case of fern prothallia, failed to produce the least effect. Again, the remarkable experimental results of Correns on diecious flowering plants (*Bryonia*) prove that the pollen-grains, though apparently alike morphologically, are predestined in equal numbers as male-producing and female-producing. Half the pollen-grains upon fertilizing the eggs produce males and half females. In the mosses the Marchals demonstrate that all the products of a single spore are likewise immutably determined, since new plants formed by regeneration from fragments of the protonema or from any part of the gametophyte, are always of the same sex. Evidently, sex is here a quality that pervades all the cells of the organism, independently of the external conditions. These results tally with a considerable body of evidence on the zoological side that all the products of a single egg are of the same sex. This is shown, for example, by the similar sex of double monsters, and still more strikingly by that of multiple embryos derived from the same egg. The work of Bugnion, Marchal and Sylvestri has shown that in some of the Chalcidæ (*Encyrtus, Litomastix, Ageniaspis*) each fertilized egg produces large numbers of secondary embryos by an asexual process. All of those arising from a single egg are of the same sex—female if the egg be fertilized, male if it be unfertilized, as in the bee and ant.

III. CYTOLOGICAL BASIS OF THE SEXUAL PREDESTINATION IN THE AIR-BREATHING ARTHROPODA

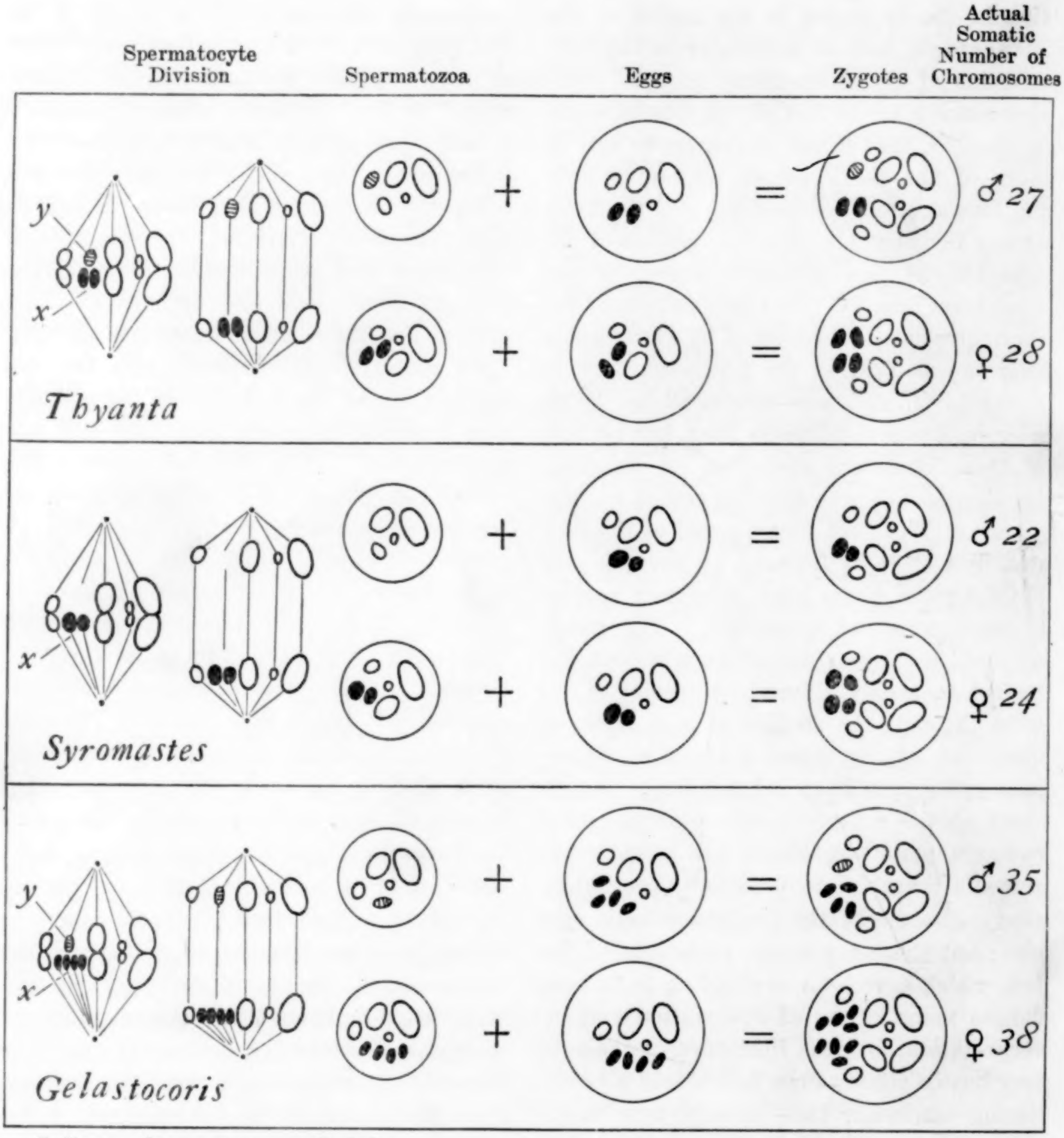
In none of the cases just cited is anything positively known of the cytological basis of the sexual predestination in the germ-cells. Our knowledge of this side of the question is thus far confined to three groups of the air-breathing arthropods, but we here find a substantial basis for a broader consideration of the entire problem. Cytological studies on insects, myriapods and arachnids have demonstrated that in many of these forms a sexual predestina-

tion is clearly shown in the nuclei of the spermatozoa, and in particular in the constitution of the chromosome groups. The spermatozoa are in fact of two classes, equal in number, that differ in respect to one or more of the chromosomes that enter into the formation of their nuclei; and the facts clearly demonstrate that fertilization of the eggs by one class produces males, by the other class females. This dimorphism of the spermatozoa was discovered by Henking as long ago as 1891 in the hemipteran genus *Pyrrochoris,* and was confirmed by Paulmier in *Anasa* eight years later, but neither of these observers suspected its meaning. Its significance was first suggested by McClung in 1902, but direct proof of the fact was first brought forward by Stevens and Wilson three years later in certain species of hemiptera and coleoptera. The result attained in these species has now been extended to nearly a hundred species of insects through the studies of a number of observers, among whom a group of American cytologists have led the way. In all these species sex-production conforms to a common principle, which has recently received a beautiful confirmation through the study of some of the parthenogenetic species; but there are many variations of detail, which have been so puzzling as to have caused many errors of observation and interpretation, and the literature of the subject has in consequence fallen into a bewildering confusion that is only now fairly being cleared away. I will state the essential facts as briefly as possible.

In all the species half the spermatozoa are characterized by the presence of a special nuclear element which I shall call the "X-element," while the other half fail to receive this element. In the simplest and clearest case (which was that first discovered) the X-element is a single chromosome, now generally known by the name of the "accessory chromosome," given to it by McClung, but it is also called the "odd" or "heterotropic" chromosome, the "monosome," or the "unpaired idiochromosome." I will here employ McClung's more familiar term. As a single accessory chromosome the X-element has been found in many representatives of the hemiptera, orthoptera and coleoptera, and in certain odonata, myriapoda and arachnida. The typical accessory chromosome has no synaptic mate or partner; and here lies the explanation of the fact that in the maturation divisions it passes into only half the spermatozoa.[2] In many cases, however, the X-element (otherwise identical with an accessory chromosome) appears as a "large idiochromosome" which has a synaptic mate known as the "small idiochromosome." This latter chromosome, or its homologue, I shall designate as the "Y-element." In a few cases the X-element consists of two chromosomes (*Thyanta, Fitchia*), of three (*Prionidus, Sinea*), or even of four (*Gelastocoris*), accompanied in each of these cases by a single Y-element. In *Syromastes* (at present a unique case) the X-element is double, but is not accompanied by a Y-element.[3] In all cases the spermatozoa are formed in pairs, and the chromosomes are so distributed in the maturation-divisions that one member of each pair receives the X-element (whether it consist of one, two or more chromosomes), the other member the Y-element if it be present. This is illustrated by the accom-

[2] The two members of every pair of chromosomes are separated in the reduction division and pass, respectively, into the members of a corresponding pair of spermatozoa. Hence the reduction of the original number to one half in each spermatozoon, and hence also the failure of one member of each pair of spermatozoa to receive the X-element.

[3] The cases of *Fitchia, Prionidus* and *Sinea* are reported from unpublished observations by Mr. F. Payne, made in my laboratory.

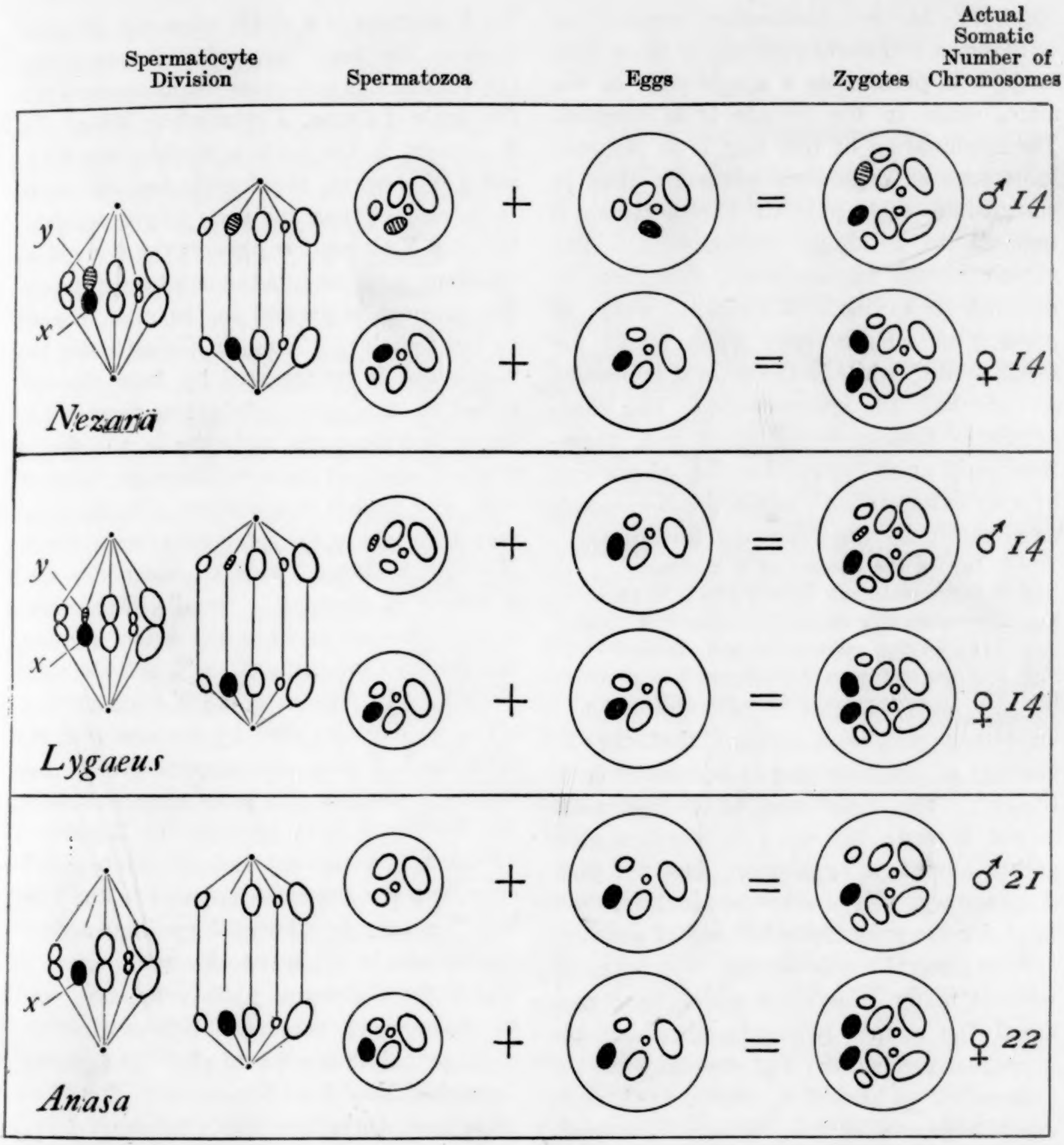


Ordinary chromosomes—unshaded.
x element—black.
y element—with cross-bars.

panying diagrams.[4] Half of all the spermatozoa thus receive the X-element, while the other half may receive a Y-element in its place, though this may be absent.

Comparison of the male and female somatic chromosome-groups proves, indirect-

[4] These diagrams are from my own observations with exception of those of *Gelastocoris* (from Payne). For the sake of simplicity and ready comparison all the forms are represented with but four pairs of ordinary chromosomes (in white), all with the same size-relations and grouping. The X-element is in each case black, the Y-element cross-barred. The actual numbers of the chromosomes are given for each sex at the right.



Ordinary chromosomes—unshaded.
x element—black.
y element—with cross-bars.

ly, but conclusively, that the two classes of spermatozoa thus formed are, respectively, female-producing and male-producing (I do not say female- or male-*determining*), as already stated. In both sexes the somatic groups are identical save in respect to the X- and Y-elements; and the difference can only be a result of fertilization by the two respective classes of spermatozoa. This is at once proved in species having a Y-element by the fact that this chromosome is found only in the male. The evidence given by the X-element alone is equally decisive. This is present in both sexes, but,

whatever be its particular composition (whether a single chromosome or more than one) it is present as a single unit in the male, while in the female it is doubled. The explanation of this fact is as follows: It is true of organisms generally that in maturation each pair of chromosomes is reduced to a single chromosome. The X-pair in the female must, therefore, be reduced to a single X-element, which is present in all the eggs when ready for fertilization,[5] while in the male it is present in only half the spermatozoa. The characteristic female combination can, therefore, only arise by fertilization of the egg by spermatozoa that contain the X-element, as is shown by the following formulas:

(*a*) In the absence of a Y-element

Egg X + spermatozoon X = zygote XX (female)
Egg X + spermatozoon no X = zygote X (male)

(*b*) In the presence of a Y-element

Egg X + spermatozoon X = zygote XX (female)
Egg X + spermatozoon Y = zygote XY (male)

In either case it is evident that the X-element of the male zygote is derived from the egg. The significance of the Y-element is not known; but since it is often altogether absent, it apparently does not play a necessary rôle in sex-production, and may, for the present, be left out of account.

This general result has not been attained without many false steps which have confused the simple principle to which the phenomena conform; but so many of the contradictions have disappeared upon more exact later studies that we may now confidently expect to see the few remaining ones cleared away.

It is clear from these facts that the sexes often differ in the number of the chromosomes; and in this case it is always the female that has the larger number. When the X-element is a single unpaired chromosome in the male (accessory chromosome) the female has one more chromosome than the male (*Anasa, Protenor*). When the X-element in the male is double, but without a Y-element, the female has two more chromosomes than the male (*Syromastes*).[6] When a Y-element is present the numerical relations are modified accordingly (since this element is present in the male, absent in the female). Thus, in *Gelastocoris* the X-element is represented by four chromosomes in the male, while the female has eight; but since the male has in addition a single Y-element the net difference between male and female is but three. In the common case where the male contains a single X-element (large "idiochromosome") and a single Y-element ("small idiochromosome") the sexes have the same number, the female containing X + X and the male X + Y. In this case the Y-element may often be distinguished by its size and the male and female chromosome-groups are visibly different. In some cases, however, the Y-element is as large as the X-element (*Nezara, Oncopeltus*) and no visible difference between the sexes appears to the eye; but this case is connected by intermediate gradations in other species with cases in which the difference plainly appears, and we have every reason to believe that the same principle applies to all. The general formulas X + X = female and X + Y = male may, therefore, apply to many forms in which no nuclear differences between the sexes are visible.

The general conclusion reached by the study of the purely sexual forms has recently received a most convincing confirmation through the brilliant discoveries of Morgan and von Baehr on some of the

[5] This part of the conclusion, at first based on indirect evidence only, has recently been shown to be true by observations, still unpublished, by Mr. C. V. Morrill.

[6] The female number in this case, which I at first inferred only, has recently been demonstrated by direct observation.

parthenogenetic forms, which have hitherto seemed to constitute a serious difficulty. Some years ago Meves discovered that in the bee half the spermatocytes are very small and degenerate without forming functional spermatozoa, and Meves compared these to polar bodies, but seems not to have suspected their significance in relation to sex-production. Morgan discovered in *Phylloxera* and von Baehr independently in *Aphis saliceti*, that a similar degeneration of half the spermatocytes takes place, and further, that these are the ones that fail to receive the "accessory chromosome" (*i. e.*, the X-element). Functional spermatozoa are produced only from those spermatocytes into which the accessory chromosome passes, and these obviously correspond exactly to the female-producing class in the ordinary case. These observations have since been extended by Miss Stevens to a considerable number of species of aphids. A complete explanation is thus given of the fact, which has long been a puzzle, that in these animals all the fertilized eggs produce females. Not less interesting is the discovery by Morgan and von Baehr that in both the forms in question the males, though produced from the females strictly by parthenogenesis, have one chromosome fewer than the females. The male-producing egg must therefore eliminate one chromosome, and this, we can not doubt, is the X-element. What has hitherto seemed to be a stumbling-block in the way of the general conclusion is thus seen to be in reality a remarkable confirmation.

To what extent these conclusions, based upon the study of the arthropods, will be found to hold true for other organisms remains to be seen. The experimental results of Correns on the flowering plants, which harmonize completely with the cytological results on the insects, certainly seem to give good reason to expect that the general principle involved will be found to hold true of a large series of forms.

IV. SEXUAL PREDESTINATION AND HEREDITY

Deferring for the moment the question of the sex-ratios, let us now attack the most difficult but perhaps most interesting part of our inquiry, which concerns the nature of the sexual predestination and its relation to the phenomena of heredity in general.[7] In the air-breathing arthropods, as has been seen, a dual sexual predestination of the spermatozoa is clearly seen. Does such dual predestination exist also in case of the sexual eggs? Could we rely on the cytological evidence alone we should unhesitatingly say, no; for it is clear that all the mature eggs are cytologically alike. Moreover, in the aphids and daphnids and rotifers the sexual eggs are all alike destined to produce females; and although it is possible that a male-producing class degenerates (like the corresponding class of spermatozoa), there is no evidence of this. The facts here evidently suggest

[7] Here again caution in our use of terms is necessary. Obviously in the cases we have been considering the spermatozoa are, in a purely descriptive sense, predestined as male-producing and female-producing. But it by no means follows that they are predetermined as male and female or even that they are male-determining and female-determining. Sexual predetermination and sexual predestination must not be confused, as is clearly shown by Corren's discovery that the pollen grains of diecious flowering plants are prospectively predestined as male-producing and female-producing, though their immediate products (the rudimentary prothallia) are all males. It would seem that there are here two kinds of males, which give rise, respectively, to male-producing and to female-producing gametes. Clearly, the definitive determination of maleness or femaleness only occurs when all the factors necessary to their production have been brought together. This *may* be effected before fertilization ("progamic determination" of Haecker), but may also first ensue upon union of the gametes ("syngamic determination").

that the eggs are determined as females by their combination with the spermatozoa, and that fertilization may here be considered as the immediate determining cause of the female sex. In the bees and other social Hymenoptera this conclusion is still more probable, even though the Dzierzon theory fall short of a complete demonstration. But this does not yet touch the root of the matter. It is more than possible that even in organisms that are incapable of parthenogenesis the unfertilized egg may in itself bear a sexual "tendency" which would cause it to develop into a male or female could parthenogenesis take place. This is shown by the bees and ants where the unfertilized sexual eggs produce males, and the conclusion seems unavoidable that all bear the male tendency. Both here and in the rotifer (if Maupas's conclusion be correct) the innate tendency of the egg is male; but this is not a fixed predetermination since it is reversed or suppressed by fertilization.

V. MENDELIAN THEORIES OF SEX-HEREDITY

We are thus brought to the central problem of sex-production, namely, the nature of the sexual tendencies of the gametes and their interaction. Can sex be treated as a form of Mendelian heredity, in which the gametes bear male and female tendencies or factors that correspond to those which represent the dominant and recessive members of a pair of allelomorphs? Should we think of maleness and femaleness as due to the presence in the egg of specific male and female determinants that disjoin in maturation and recombine in fertilization? That sex may be such a phenomenon was first suggested by Strasburger, and the conception has since been more fully developed, first by Castle and afterwards by Correns and Bateson, each in his own way. There are many facts that seem to speak in its favor. Each sex seems to show indications of the presence of the opposite sex in a latent or recessive condition. In hermaphrodites both sexes are present in the active state and may either appear side by side or may dominate successively. In diecious forms there seems to be no escape in certain cases from the conclusion that opposite sexual tendencies disjoin in the maturation divisions. One of the best examples of this is given by the diecious mosses, already referred to. As the Marchals's work shows, each spore and all of its products is irreversibly predetermined as male-producing or female-producing, and spores of both kinds are found in the same capsule. It would seem, therefore, that the two tendencies must be brought together in fertilization; and we should expect to find that the zygote or its products (the sporogonium) should combine the two. Such is indeed the fact. Moss plants (gametophytes) formed by regeneration from the stalk or wall of the sporogonium are either actually hermaphrodite or produce hermaphrodites in a succeeding generation (again formed by regeneration)—a condition never found in the normal gametophytes developed from the spores. But since the spores, formed by the two maturation divisions from the mother cells in the sporogonium, are again strictly male-producing or female-producing, the sexual tendencies must be disjoined by these divisions. Translating this into cytological terms, cells that contain only a single or haploid series of chromosomes bear but one tendency, male or female; while those that contain the double or diploid series bear both tendencies. The same appears to be true in the liverworts (*Marchantia*) according to the observation of Noll and Blakeslee.

With this the facts in the aphids and similar cases, as far as they go, seem to be in essential agreement. The summer parthenogenetic eggs form but one polar

body, and, as shown by Miss Stevens and others, they undergo no reduction. All these eggs produce females; but the male tendency must be present in a latent or recessive form, since males are ultimately produced without fertilization. In the maturation of the male-producing egg but one polar body is formed and no general reduction occurs. But, as already stated, the males nevertheless contain one chromosome fewer than the females, and the male egg must, therefore, in some way eliminate one chromosome, *i. e.*, reduction occurs in the case of one chromosome-pair. It can hardly be doubted that this pair is formed by the two X-elements (accessory chromosomes). At first sight, therefore, the conclusion seems inevitable that one of the X-elements bears the female tendency, the other, the male. It is probable that a similar process occurs in the bee and the ant. In the latter cases the eggs must, of course, originally bear the female tendency; but after the formation of both polar bodies all bear the male tendency; and it seems again at first sight impossible to avoid the conclusion that the female tendency is eliminated in the course of maturation. The same conclusion is indicated by Maupas's results on *Hydatina*.

It is evident from these facts that the explanation of sex-production is to be sought in a mechanism that is essentially similar to that involved in alternative heredity, and that a strong case can be made out for the Mendelian interpretation on this basis. This interpretation has been worked out in three forms, which exhaust the *a priori* possibilities. These are, first, that both sexes are sex-hybrids or heterozygotes (Castle); second, that the male alone is a heterozygote, the female being a homozygote recessive (Correns); third, that the female is the heterozygote, the male being a homozygote recessive (Bateson). I will very briefly examine each of these hypotheses.

The earliest of the three was that of Castle, according to which the fertilization formulas would be

Egg ♀ + spermatozoon ♂ = zygote ♀(♂) (female)
Egg ♂ + spermatozoon ♀ = zygote ♂(♀) (male)

or

Egg ♀ + spermatozoon ♂ = zygote (♀)♂ (male)
Egg ♂ + spermatozoon ♀ = zygote (♂)♀ (female)

according as the dominant character is borne by the egg or the spermatozoon. In either case a selective fertilization must be assumed, since only gametes bearing opposite tendencies unite.

This interpretation encounters two principal difficulties. One is the necessity of assuming selective fertilization, which, though possible, seems *a priori* improbable. The other is the case of the bee and some other hymenoptera, which was pointed out by Castle himself but is now seen to be even more serious than he supposed. In the bee all the eggs after forming both polar bodies produce males if unfertilized, females if fertilized. Under the hypothesis, therefore, the female tendency must be derived from the spermatozoon. But this is a *reductio ad absurdum;* for the male is derived from an unfertilized egg which has by the hypothesis eliminated the female tendency. Castle offered the very ingenious explanation, based on the results of Petrunkewitsch, that the testis is derived from the polar bodies, which contain the female tendency. But this exit from the difficulty seems to be closed by the work of Sylvestri on certain of the Chalcidæ (*Ageniaspis, Litomastix*) and that of Schleip on the ant (*Formica*), which clearly proves that the products of the polar bodies in these forms do not in fact enter into the composition of any part of the body, yet the sexual relations are the same as in the bee. This difficulty seems to me to constitute a formidable obstacle

not only to Castle's hypothesis, but to the whole Mendelian interpretation.

The second hypothesis is that of Correns, which assumes the male to be a sex-hybrid while the female is a homozygous recessive. The fertilization formulas are accordingly

Egg ♀ + spermatozoon ♀ = zygote ♀♀ (female)
Egg ♀ + spermatozoon ♂ = zygote (♀)♂ (male)

This conclusion is based on the following beautiful experiments. Crosses between monecious and diecious flowering plants show that the monecious character behaves like a "unit character" which is recessive to the diecious. If reciprocal crosses be made between the monecious *Bryonia alba* and the diecious *B. dioica* the results are as follows: Female *dioica* crossed with male *alba* gives all females. The reverse cross gives half males and half females. From the fact that all the offspring of female *dioica* × male *alba* are females Correns concludes that all the eggs bear this tendency, which dominates the monecious character of the male parent. In the reverse cross the diecious character again dominates, but in this case is derived from the male parent. The appearance of the two sexes in equal numbers must therefore mean that half the pollen grains bear a dominant male tendency and half a recessive female. A similar result is reached by Noll by experiments of a quite different character on the hemp, but the proof seems to me less cogent.

Correns's experiments are of admirable ingenuity and his results seem at first sight to be open to but one conclusion. His interpretation renders the hypothesis of selective fertilization unnecessary; for the chance fertilization of any egg by any spermatozoon explains the numerical equality of the sexes in the same way that it explains the equal numbers of the two classes of offspring of an ordinary Mendelian cross between a homozygote recessive and a heterozygote. An obvious difficulty at once appears, however, in the parthenogenetic forms; for here the parthenogenetic females must bear both tendencies, since they, sooner or later, produce males without fertilization. We need not enter into Correns's suggestions in regard to the aphids and phylloxerans, since they are contradicted by the facts of the spermatogenesis. In case of the bee, he adopts Beard's supposition that there are two kinds of eggs—sexual female-producing, which require fertilization, and parthenogenetic male-producing. In the latter the original female tendency is replaced by the activation or setting free of a male tendency previously latent.[8] A similar explanation might be applied to the aphid, phylloxeran or daphnid. But does not such manipulation of the sexual tendencies greatly weaken the force of the Mendelian interpretation? To me it seems that if the sexual tendencies may thus be shifted back and forth between the active and latent states, the interpretation loses most of its explanatory value.

Can we then explain the difficulty in question by reversing Correns's hypothesis, assuming the male to be the homozygote, the female the heterozygote? This is the hypothesis of Bateson, who further suggests that different species or groups may differ in respect to the sex that is homozygous. The fertilization formulas now become:

Egg ♀ + spermatozoon ♂ = zygote ♀(♂) (female)
Egg ♂ + spermatozoon ♂ = zygote ♂♂ (male)

But new and even more serious difficulties now arise. If the male be homozygous in the ordinary forms of insects, what

[8] To understand this it must be borne in mind that Correns regards each "active" sexual tendency (whether dominant or recessive) as accompanied by a "latent" (not to be confused with a recessive) opposite tendency. Such a latent male tendency in the female, upon becoming activated, would dominate the female.

sense can be found in the production of two forms of spermatozoa? Still worse is the dilemma presented by the parthenogenesis of the bee or ant. If we here assume that the egg eliminates the female tendency in maturation, fertilization should produce a homozygous male, which is contrary to fact. If, on the other hand, we assume the male tendency to be eliminated, parthenogenesis should produce females, which is also contrary to fact. The only escape from this seems to lie in the assumption that if unfertilized the egg eliminates the female tendency, if fertilized, the male.[9] But can we regard this as probable?

VI. A PROVISIONAL FORMULATION OF THE BASIS OF SEX-PRODUCTION IN ANIMALS

I think it must be admitted that until these and various other specific difficulties have been satisfactorily met the Mendelian interpretation will fall short of giving an intelligible or adequate explanation. The general evidence in its favor is so strong that we may perhaps hope to see these difficulties cleared away by further study. In the meantime it seems to me that we shall do well to hold as closely as possible to what we actually see of the basis of sex-production in the tracheates. What we see is that males are produced from zygotes that contain but a single X-element, females from those that contain two such elements. It is interesting to see how many of the difficulties of the Mendelian interpretation disappear under the assumption, naive though it may appear, that a single X-element in itself causes or determines the male tendency, while two such elements in association create, or at least set free, the female tendency. As far as the animals are concerned, must of the facts that have been reviewed, in respect to both fertilization and parthenogenesis, fall into line with such a view. Assuming its truth, the facts work out as follows. In ordinary sexual reproduction all the unfertilized eggs should after maturation bear the male tendency because one X-element is left in the egg after reduction. If capable of parthenogenesis with the reduced or haploid number of chromosomes, such eggs should produce males (as appears to be actually the case in the bees and ants). If fertilized by a spermatozoon that lacks the X-element, the egg still produces a male, for the same reason. If fertilized by a spermatozoon that contains this element, the egg produces a female because of the introduction, not of a dominant "female tendency," but of a second X-element. How this operates to produce a female we can hardly conjecture; but in order to give point to the conception, let us assume that the X-element contains factors (enzymes or hormones?) that are necessary for the production of both the male and the female characters; that these are so adjusted that in the presence of a single X-element the male character dominates, or is set free; and that the association of two such elements leads to a reaction which sets free the female character.[10]

[9] This suggestion is due to Professor Morgan.

[10] Many well-known facts indicate that each gamete may transmit both male and female characters to the offspring. So far as the eggs are concerned (and also those spermatozoa that contain the X-element) I am, therefore, of the opinion, expressed by Correns, Morgan and other writers, that every gamete contains factors capable of producing both the male and female characters, and that this is also true of all the zygotes. In a former discussion I suggested the possibility that the same activity that produces a male might, if reenforced or intensified, produce a female. A somewhat analogous quantitative interpretation of sex, based on the nucleo-plasmic relation, has been put forward by R. Hertwig. Such purely quantitative interpretations involve certain difficulties that are avoided by the formulation here suggested, which approaches more nearly to a Mendelian interpretation.

In what measure such a formulation of the facts may be adequate will find its test in the facts of parthenogenesis; and while these are not sufficiently known to give a positive result, they seem in the case of animals to be, on the whole, not out of harmony with it. We must clearly distinguish between parthenogenesis with and without reduction, for in the former case one X-element is eliminated, while in the latter case both are presumably still present. Parthenogenesis preceded by the formation of a single polar body without reduction occurs in the summer generations of aphids, phylloxerans, daphnids and rotifers, and in all of these females are produced, since the female chromosome-combination persists unaltered. The male-producing eggs likewise form but one polar body and do not undergo a general reduction. As already stated, however, in the aphid or phylloxeran they eliminate one chromosome (the X-element) and thus produce the male combination.

The crucial test of the assumption lies in the parthenogenesis of eggs which form both polar bodies; for if it be correct the egg which develops with the reduced or haploid number of chromosomes should produce a male, and that which develops with the diploid number a female.[11] The facts are not yet known with sufficient accuracy to admit of a decision, but with one or two possible exceptions the best known cases seem to be, on the whole, in harmony with this. In *Rhodites* the eggs are usually female-producing, and were long since described by Henking as undergoing a preliminary coupling of the chromosomes; but the diploid number is restored by a doubling of the chromosomes previous to cleavage. Henking interpreted both divisions as equational, and assumed that no qualitative reduction occurs. More recently Doncaster describes the female-producing eggs of the saw-fly *Pœcilosoma luteum* as also developing with the diploid number, in this case without a previous coupling and doubling. Both these cases are therefore in harmony with the assumption. In the ant and bee the male producing eggs were supposed by Henking (*Lasius*) and Petrunkewitsch (*Apis*) to undergo reduction followed by doubling, as in *Rhodites,* which would be a contradiction to the assumption; but neither of these conclusions is borne out by more recent work. Schleip's studies on the ant (*Formica*) leave little doubt that the unfertilized eggs of the workers develop, at least up to a late stage, with the reduced number (24) and that the fertilized female-producing eggs of the queen develop with twice this number. In case of the bee, likewise, the work of Meves on the spermatogenesis renders it almost certain that Petrunkewitsch was misled, the number 16, which he observed in the cleavage of the drone eggs, being the reduced number. The ant and bee therefore also fall into line with the assumption. A difficulty, on the other hand, appears in Doncaster's results on the parthenogenetic eggs of a saw-fly (*Nematus ribesii*), which is said to produce usually males, but sometimes females. Doncaster makes the extremely interesting observations that there are here two types of maturation, both polar bodies being formed in each case, but in one type reduction occurs, in the other it does not. If we could assume that the former type is male-producing, the latter female-producing, the general assumption would receive a strong confirmation; but the spermatogonia are described as dividing with the diploid number. If this is

[11] There is, however, a possibility that in female-producing eggs reduction might occur in respect to all the chromosomes except the X-pair, which would form the converse case to that observed by Morgan in Phylloxera.

correct, it seems to negative the assumption.

Although, therefore, many of the facts of animal parthenogenesis harmonize with the naïve assumption that the presence of one X-element means the male tendency, of two such elements the female tendency, we are not yet in a position to assert that this is always the case; and the problem may be complicated by the presence of factors still unknown. We are led to suspect that this is really the case by the apparent disjunction of the sexual tendencies that occurs in the formation of the asexual spores of plants. Botanical cytologists are agreed, I believe, that such spores develop with the reduced or haploid number of chromosomes, yet they may produce either males or females. This seems irreconcilable with the view that half the spores contain an X-element which is lacking in the other half. But we are led, nevertheless, to suspect from the facts known in animals that the male-producing spores may be characterized by the absence of some element that is present in the female-producing ones; and the detailed study of the chromosomes has given us so many cytological surprises in recent years that we may well await more intimate acquaintance with the facts in the plants before drawing any definite conclusion in this case.

I can only touch here upon the possible relation of hermaphroditism to the phenomena seen in diecious forms. If the hermaphrodite condition were a synthetic one, formed by the union of male and female tendencies that are separately borne as such by the gametes, a serious difficulty would be presented to the provisional formulation that has been suggested. But it seems clear from the experiments of Correns and others that hermaphroditism, at least in the higher plants, should not thus be conceived. Hybridization experiments seem to prove that the hermaphrodite tendency is borne as such by all the gametes, so that the heredity of hermaphroditism is closely similar to that of the spotted or "mosaic" type of coloration in animals. The hermaphrodite character is, in other words, a unit character which does not split into separate male and female tendencies in the gametes. There seems, accordingly, to be as much reason to postulate in this case a special "hermaphroditic factor" which liberates both sexual capacities, as a special mosaic or mottling factor in the case of mosaic pigmentation. I have no desire to spin hypotheses, but will suggest that the same general view as that suggested for the diecious forms can be applied to the hermaphrodite if we assume that all the gametes alike contain an X-element and in addition an "hermaphroditic factor" which enables both male and female characters to come to expression." It can, I think, be shown that the results of Correns's crosses can be interpreted in the terms of such an assumption; but it does not seem worth while to speculate in this direction until more is known of the facts.[12]

I wish very distinctly to say that in any case I should only regard the naïve formulation of the facts here outlined as a provisional one which may have no other value

[12] How little we yet know of the true nature of hermaphroditism is shown by the Marchals' results on the diœcious mosses. The hermaphrodites artificially produced by regeneration from the sporogonial tissue are in this case evidently synthetic, since they are formed by the union of separate male and female "tendencies"; but such hermaphroditism would seem to be of quite different nature from that of normally hermaphroditic species. The same experiments prove that there may likewise be two forms of males and females; for the apparently male or female plants produced by regeneration from the sporogonial tissue are potential hermaphrodites (as is proved by their regenerative offspring) and differ widely in this respect from the normal males and females.

than as a possible guide to inquiry. There are many reasons for suspecting that it does not reach the root of the matter. One of them is the failure to account for the significance of the Y-element, which is as characteristic of the male sex, when it is present, as is the double X-element of the female. Another is the possibility, which is perhaps a probability, that other factors than the chromosomes may play an essential rôle in sex-determination. The data do not yet allow us to draw a positive conclusion on many of the detailed questions of this kind. But our ignorance in regard to these more specific problems does not alter the fact that the cytological evidence has revealed a visible mechanical basis for the production of males and females in equal numbers and irrespective of external conditions; and this, I venture to think, constitutes a real and important advance in the investigation of the general problem of sex.

VII. THE SEX-RATIO IN RELATION TO THE CYTOLOGICAL BASIS OF SEX-PRODUCTION

We are thus led, finally, to the question of the sex-ratios as they appear in the light of the foregoing conclusions. It is well known that different species often exhibit characteristic differences in the ratio of males to females; and this fact has been urged by some writers as an argument against the existence of an intrinsic and uniform mechanism of sex-production and against the specific assumption that sex is transmitted as a Mendelian character. The cytological facts seem to me, on the contrary, to offer the most valuable suggestions for an understanding of the variations of the sex-ratio. This appears from a consideration of the extreme case where all the fertilized eggs produce the same sex, as in the aphids, daphnids and the like. A complete explanation of these cases seems to be given by the discovery that only the female-producing spermatozoa are functional. May we not here find a clue to the explanation of less extreme departures from the equal ratio shown in other forms? It is probable that the suppression of the male-producing spermatozoa in the aphids and phylloxerans was gradually brought about, and was connected by intermediate stages with the usual condition in which both classes of spermatozoa are equally functional. Stevens finds that in the aphids all degrees of inequality exist between the two classes of spermatocytes, though none of the male-producing class seem to give rise to spermatozoa. It seems reasonable to suppose that such a condition has followed one in which only a part of the male-producing class became impotent or degenerate. Owing to the enormous number of the spermatozoa, such a partial impotence of this class would produce no noticeable effect on the sex-ratio until it had proceeded very far. Sooner or later, however, the proportion of males from fertilized eggs would be reduced, and finally extinguished. Such a process would lead to the extinction of the species were it not for a compensatory parthenogenetic production of males, such as, of course, exists in cases where all the fertilized eggs produce females.

As bearing on this question I may recall the well-known fact that among the flowering plants a certain proportion of the pollen grains are often impotent, sometimes in a definite ratio. Correns, for example, finds that in *Mirabilis longiflora* there are three impotent to one functional; in *M. jalapa* the ratio is four to one. Such facts are most suggestive in their bearing on the whole question of sex-ratios, and the possibility of their alteration by external agents. Since the two classes of spermatozoa differ in nuclear constitution it is highly probable that they differ in respect to their meta-

bolic processes. It is, therefore, well within the range of possibility that the reaction between egg and spermatozoon may differ in respect to the two classes. Such physiological differences may vary in different species and may be capable of modification by external agents acting upon either sex. Again, the difference of mortality between the sexes, which is probably one of the modifying factors of the sex-ratio, may perhaps be traceable to differences of metabolism that have their original root in the sexual difference of nuclear constitution. In the directions here indicated lie many possibilities regarding the natural or artificial modifications of the typical sex-ratio of which no account has hitherto been taken. Until they have been thoroughly reckoned with, I think that all results upon the sex-ratios that are based upon general statistical and experimental inquiries must be taken with great caution. Taken as a whole, the evidence now indicates that in diecious organisms generally the basis of sex-production is primarily adapted for the production of males and females in equal numbers, and that departures from equality are due to secondary modifications.

VIII. CONCLUSION

A review of the ground that has been traversed will, I think, leave no doubt regarding the answer that should be given to the general question that formed our point of departure. The conclusion has become in a high degree probable that sex is controlled by factors internal to the germ-cells, that the male or female condition does not arise primarily as a response of the developing germ to corresponding external conditions. Such conditions may operate to modify the action of the internal mechanism, but the process of sex-production is fundamentally automatic. In so far as sex has been traced to a predetermination of the fertilized egg, or to a predestination of the gametes that unite to produce it, the problem of sex-production may be said to have reached a proximate solution. But it is perfectly obvious that this solution is proximate only, and has but opened the way to a more searching analysis of the nature of sex. Upon what conditions within the fertilized egg does the sexual differentiation depend? In some way, we may now be reasonably sure, upon the physiological reactions of nucleus and protoplasm; but the same may be said of any other form of heredity. The specific problem of sex here merges into the larger one of heredity and differentiation in general, and the minor problem acquires a broader interest through the hope that it gives us of attaining a solution of the major one. Into this aspect of the subject I will not now enter. I hope to have given some justification for the assertion, made at the outset, that substantial progress has been made in the exact analysis of the sex-problem. Recent researches have given good reason to believe that sex-production is governed by a common, and perhaps relatively simple principle. They have demonstrated that it has a definite morphological basis, which, even though its mode of action is not yet fully comprehended, is susceptible of accurate microscopical and experimental analysis. They have given a new point of view for the experimental and statistical analysis of the problem. And the progress already made encourages us to hope that a more complete solution may not be very far away.

The history of the subject throws an interesting light upon the methods of biological inquiry. The reform that is taking place in zoology through the extension of the experimental method has sometimes produced a disposition to exalt this method above others, and the same may be said in

respect to exact statistical research. Both these methods are indispensable. But it is well to remember that the sex problem was first attacked by such methods, and that they long gave inconclusive or wholly misleading results. The most fruitful suggestions for its solution were first given by morphological studies, in which minute cytological research has latterly played an important part, while the newer experimental work is bringing complete demonstration to these suggestions. It would be hard to find a better illustration of the futility of placing exclusive trust in any single method for the solution of any complex biological problem. If a definitive solution is to be attained it will be a result of the alliance between observation and experiment, between morphology and physiology, which is fortunately becoming the distinctive feature of modern zoology and botany.

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PROFESSOR ALFRED GIARD (1846–1908)

Science in France has suffered an untimely loss in the death of Professor Giard. He was stricken suddenly (d. August 8) while in the height of his activities, relatively young, keen in his interest in new biological tendencies. His influence had long been felt in the advancement of science; and his absence will be regretted not alone in his native country. He was one of the foremost naturalists of his day, a man of vast erudition, and of original views.

His bent for natural history showed itself from his earliest youth. As a child of six he was already a passionate observer of nature, helped and encouraged by his father, who found the time to scour with him the surrounding country, the streams, the woods, the moats of the fortifications of Valenciennes, his native town; in this way he began to lay up a store of valuable information by personal experience, and to acquire the veritable instruction and education which he himself recommends in an article, charming and profound, published a few days before his death.[1] As attentive in reading and assimilating the writings of his predecessors as in observing all that took place around him, he early acquired a ripeness of judgment and a knowledge of facts noticeable in his very first writings, and particularly striking in his thesis for the degree of doctor.[2]

Appointed professor of natural history in Lille in 1873, Alfred Giard rapidly organized a zoological center and trained many remarkable naturalists, among others Charles, Jules and Théodore Barrois, P. Hallez, P. Pelseneer, L. Dollo. His profound knowledge of botany, as well as zoology, enabled him to teach both subjects with equal success. An enthusiastic convert to transformism, he introduced this doctrine into France by his teachings and writings, in spite of the most active opposition.

In 1874 he founded at Wimereux, near Boulogne (Pas-de-Calais), a zoological marine station; it was a tiny building with but scanty accommodation for the numerous and busy workers who rapidly assembled there, but it was destined to accomplish much useful work, as will be seen by its output—the *Bulletin Scientifique de la France et de la Belgique*, has now its forty-second volume in press, and there are eight volumes in quarto of *Travaux de la Station Zoologique de Wimereux.* There he passed his holidays living among his pupils in the most informal way, exploring with them the shore at low tide, the sand-hills surrounding the laboratory, the woods and highways farther afield, amazing all by the extreme variety of his knowledge and his wide-spread erudition, and opening to their eager eyes many unsuspected biological associations. It is only to be deplored that Giard's results on the fauna and flora of the region of the Boulogne, studies which extended over a period of twenty-four years, remain unpublished. At the time of his death he was gathering together his voluminous

[1] "Education du Morphologiste," *Revue du Mois*, 10 Juillet, 1908.

[2] "Recherches sur les Ascidies composées ou Synascidies," *Archives de Zoologie Expérimentale*, t. I., 1872.

notes and hoped to bring them out in a separate publication.

Giard stayed in Lille until 1887, when he accepted a call to Paris as professor in the École Normale Supérieure, and a year later the municipality created for him a professorship in the Sorbonne for the Évolution des Êtres organisés, which he occupied up to the time of his death.

In 1900 he was elected a member of the Academy of Sciences, and during the last few years several of the most important foreign academies had likewise admitted him to their ranks.

There was scarcely a contemporary naturalist who possessed in similar degree Giard's gift of interesting and attracting younger workers. His manner was cordial, happy, inspiring; his students felt that they could rely upon him, and he in turn guided their steps with the keenest interest, gave them his personal support in their career and rejoiced with them in their success. He was not only a master but a true and wise friend.

His science was eminently altruistic; he worked surrounded by his pupils, happy to see them continue and complete discoveries which he had already outlined. His faculty of observation drew his attention to what might prove interesting in many branches. In almost every group he found material for study, and his works consisted chiefly of short papers, results of personal investigations, full of original and suggestive ideas. Nearly every aspect of biology was touched upon—systematic zoology, anatomy, embryology, etiology, comparative pathology, teratology, applied zoology, botany, zoological philosophy. His papers are dispersed among a multitude of periodicals, and it would be a difficult task to collect them had there not been published the usual complete bibliography and résumé (1896) when he was admitted to the Academy of Sciences.[3]

I will mention only a few of Giard's most important results: such, for example, are his numerous researches on parasitism, during which he discovered many very curious types, *e. g.*, the orthonectida, also an admirable series of papers in collaboration with Jules Bonnier on the epicarides, the isopodous parasites of crustacea. His synthetic genius, combined with minute observation and rare erudition, enabled him to seize and combine ideas and facts which would otherwise seem to have no connection, and he introduced into general biology new and important ideas founded on well-proved experiences. For instance, the action of water and the phenomena of *anhydrobiosis*, the curious modifications produced by parasites on their hosts, *e. g.*, in cases of castration by parasites, and the interesting variations of development of individuals of the same species or closely approaching species which he called appropriately pœcilogony.

Giard was one of the few naturalists who had the gift of being both original and encyclopedic. He possessed in an unusual degree a knowledge of infinite details of nature and of general philosophy, as one can judge indeed from the lecture he delivered at St. Louis in 1904.[4]

His brilliant intellect and prodigious memory enabled him to retain the quantity of material contained in his wide-spread readings, so that he was really a living encyclopedia and always up to date, opening immediately at the page wanted, to be examined at leisure by all who desired to acquire knowledge.

All these qualities remained unobscured to the last day of his life, and his loss is felt as an untimely one to all who came in touch with his many activities.

It is as though a torch carried before the crowd to light the way had been too soon extinguished.

M. CAULLERY
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SCIENTIFIC NOTES AND NEWS

DR. DAVID STARR JORDAN, president of Stanford University, has been elected president of the American Association for the Advancement of Science for the meeting to be held

[3] "Exposé des titres and travaux scientifiques (1869–96) d'Alfred Giard," Paris, 1896, in quarto, 396 pp.

[4] "Les tendances actuelles de la morphologie et ses rapports avec les autres sciences."

next year in Boston. The vice-presidents for the sections and newly elected secretaries are as follows:

Section A—Mathematics and Astronomy—Professor Ernest W. Brown, Yale University.

Section B—Physics—Dr. L. A. Bauer, Carnegie Institution, Washington, D. C.

Section C—Chemistry—Professor William McPherson, Ohio State University.

Section D—Mechanical Science and Engineering—Dr. J. F. Hayford, U. S. Coast and Geodetic Survey.

Section E—Geology and Geography—Dr. R. W. Brock, director of the Canadian Geological Survey.

Section F—Zoology—Professor William E. Ritter, University of California.

Section G—Botany—Professor D. P. Penhallow, McGill University.

Section H—Anthropology and Psychology—Dr. William H. Holmes, Bureau of American Ethnology.

Section I—Social and Economic Science—President Carroll D. Wright, Clark College.

Section K—Physiology and Experimental Medicine—Professor Charles S. Minot, Harvard Medical School.

Section L—Education—Professor J. E. Russell, dean of Teachers College, Columbia University.

General Secretary—Professor Dayton C. Miller, Case School of Applied Science.

Secretary of the Council—Dr. F. G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution.

Secretary of Section H—Anthropology—Professor George Grant MacCurdy, Yale University.

Secretary of Section K—Physiology and Experimental Medicine—Dr. George T. Kemp, Champaign, Ill.

The officers of the American Society of Naturalists elected at the Baltimore meeting are as follows: *President,* Professor T. H. Morgan, of Columbia University; *Vice-president for the Eastern Section,* Professor W. H. Howell, Johns Hopkins University; *additional members of the Council,* Dr. D. T. MacDougall and Professor Charles H. Judd. Professor H. McE. Knower and Dr. Hermann von Schrenck were reelected as secretary and treasurer, respectively.

Presiding officers of societies meeting at Baltimore were elected as follows: The Geological Society of America, Mr. G. K. Gilbert, of the U. S. Geological Survey, for the second time, he having held this office in 1892; The American Chemical Society, Dr. W. R. Whitney, director of the Research Laboratories of the General Electric Company, at Schenectady; The American Zoological Society, Professor Herbert E. Jennings, of the Johns Hopkins University; The American Anthropological Association, Dr. W. H. Holmes, chief of the Bureau of American Ethnology; The American Psychological Association, Professor Charles H. Judd, professor of psychology at Yale University and director-elect of the School of Education in the University of Chicago.

Professor T. C. Chamberlin, after presiding at the Baltimore meeting of the American Association, left for San Francisco on his way to China, where he will study the geology of the country with special reference to its influence on social and educational conditions, as a member of a commission sent by the University of Chicago.

Dr. Ernst Haeckel, professor of zoology in the University of Jena, will retire from active service at the close of the present semester.

At the commemoration of the centenary of Charles Darwin by the University of Cambridge in June, 1909, the Royal Geographical Society will be represented by its president, Major Leonard Darwin.

Professor Hermann Volz, the sculptor of the Bunsen monument at Heidelberg, has been given an honorary doctorate by the university.

Sir Archibald Geikie will give an address on the occasion of the celebration of the fiftieth anniversary of the Geological Society of Glasgow to be held on January 28.

Dr. Norman E. Ditman, instructor in pathology at Columbia University, has been appointed by President Butler chairman of a committee of twelve to investigate and report at an early date, upon the feasibility of establishing at Columbia a school or department of sanitation.

Dr. J. J. Kinyoun has been appointed pathologist and Dr. Truman Abbe, radiologist

on the staff of the Tuberculosis Hospital at Washington.

Dr. Edward C. Hill has been appointed chemist in charge of the state station of the United States Department of Agriculture recently opened in Denver.

A dinner was given at Saranac Lake on December 19, at which Dr. Baldwin presented Dr. E. L. Trudeau with two volumes of reprints on the "Studies in Tuberculosis" by his pupils in commemoration of his sixtieth birthday. Dr. Walter V. James presented Dr. Trudeau with letters from personal friends congratulating him on the occasion.

We learn from the *Journal* of the American Medical Association that the French government has conferred the decoration of the Legion of Honor on Dr. Carlos J. Finlay, of Havana, in appreciation of his discoveries in regard to the transmission of infection by mosquitoes. The presentation of the decoration was celebrated, at the same time as his seventy-fifth birthday, at a special meeting of local and national notables in the assembly hall of the Academy of Sciences, Havana. At the same time a decree of the provisional governor was read setting forth the importance to the Cuban people of the professional services of Dr. Finlay, especially in connection with the discovery of the means of transmitting yellow fever. This decree provides for the retirement of Dr. Finlay at his own request and because of his advanced age, from the position of chief sanitary officer, and for his appointment as honorary president of the National Board of Sanitation and Charities, which office is created for his life time and will terminate with his death. The salary of this position is to be $2,500 per year. The decree also provides for the publication by the government of a volume of selections from the writings of Dr. Finlay, not to exceed 500 pages nor 1,000 copies.

The Board for Biology and Geology at Cambridge University has adjudged the Walsingham medal for 1908 to C. C. Dobell, B.A., fellow of Trinity College, for his essays entitled "Protista parasitic in frogs and toads," and "Chromidia and the binuclearity hypotheses"; and a second Walsingham medal to G. R. Mines, B.A., Sidney Sussex College, and D. Thoday, B.A., Trinity College. Mr. Mines's essay was entitled, "The spontaneous movements of amphibian muscles in saline solutions"; and Mr. Thoday's essay was entitled, "Increase of dry weight as a measure of assimilation."

Professor Frederick Starr, of the department of anthropology of the University of Chicago, gave, on December 9, a lecture at the Ohio State University on "The Peoples of the Congo Free State." This lecture was the first to be given by the Society of Sigma Xi under the J. C. Campbell Lecture Fund.

George Washington Hough, professor of astronomy at Northwestern University and director of the Dearborn Observatory, known for his important observations on Jupiter and for measurements of double stars, vice-president of the American Association for the Advancement of Science in 1902, died at Chicago on January 1 at the age of seventy-three years.

Dr. J. P. Gordy, professor of the history of education in New York University, and his wife committed suicide on December 31, following the death of their only child. Dr. Gordy was born in Salisbury, Md., 1852, received the doctor's degree at Leipzig in 1884, and was professor at Ohio University and Ohio State University until he came to New York University in 1901. He was the author of works on psychology, American history and the history of education.

Dr. Richard A. F. Penrose, formerly professor in the University of Pennsylvania, and eminent as a physician and surgeon, died in Philadelphia on December 26, at the age of eighty-two years.

Mr. Joseph Lomas, lecturer in geology in Liverpool University, has been killed by a railway accident in Algeria, where he was carrying on geological investigations.

Dr. Charles Edward Beevor, known for his contributions to the knowledge of our nervous system, died in London on December 5 at the age of fifty-four years.

Dr. Ernest Hamy, professor of anthropology in the Natural History Museum, Paris, died on November 18, at the age of sixty-six years.

Lord Rosse bequeathed £1,000 to Trinity College, Dublin, for the science schools. His telescope and scientific instruments are left to his oldest son, with £2,000 for their upkeep.

A correspondent writes to the London *Times* that the Nizam of Haidarabad has established a well-equipped astronomical observatory in his dominions. The foundation of the observatory owes its origin, to the presentation by the late Haidarabad noble, Nawab Zaffer Jung Bahadur, F.R.A.S., of two large telescopes, but it is evident from the equipment of the observatory, from the selection of its director, and from the working program which has been drawn up, that his Highness intends to go far beyond the original intention of the donor, Nawab Zaffer Jung. The equipment includes, besides the purely astronomical and meteorological instruments, a very complete photographic department and extensive workshops fitted with modern tools and appliances for both wood and metal working. The program of the observatory is both comprehensive and ambitious.

By the President's order the Secretary of the Interior has withdrawn from entry all the public lands, embracing about 6,500 acres in the petroleum and natural gas field in northwestern Louisiana known as the Caddo oil field. This action is taken pending a careful geologic investigation by the U. S. Geological Survey with a view to preventing a waste of natural gas that has been estimated at 75,000,000 cubic feet a day, or more than one twentieth of the amount of this fuel usefully consumed in the United States.

President Roosevelt has signed a proclamation setting aside and naming the Ocala National Forest in Marion County, in eastern Florida, the first created east of the Mississippi River, and another proclamation creating the Dakota National Forest in Billings County, North Dakota. The two proclamations add two more states to the list of those wherein land will be put under scientific forest administration. There are now nineteen states, and Alaska, having national forests. Before the creation of the Ocala, in Florida, the two forests in Arkansas, the Ozark and the Arkansas, were the easternmost national forests. Practically all the other national forests are in the Rocky Mountain and the Pacific coast states. The Florida forest has an area of 201,480 acres, of which about one fourth has been taken up under various land laws. It covers a plateau between the St. John's and Ochlawaha rivers and at no point is an elevation exceeding 150 feet above sea level obtained. The area is by nature better fitted for the production of forest growth than for any other purpose. Nearly all of the area, however, seems particularly well adapted to the growth of sand pine which is even now replacing the less valuable species, and with protection from fire almost the entire area will in time undoubtedly be covered with a dense stand of this species. The long-leaf pine, a much more valuable commercial tree than the sand pine, appears rather sparsely in this forest and is confined principally to the lower flat lands along the streams on the borders of the forest. The new Dakota national forest consists of 14,080 acres in the Bad Lands region. Its creation is important, for it means that an experimental field for forest planting has been secured in North Dakota, the least forested state in the union, having only one per cent. of tree growth. The Forest Service expects to establish forest nurseries with the hope that in time to come the area may be reforested by artificial means. This feature is expected to prove a very good object lesson to the settlers, who it is hoped will in turn plant windbreaks around their farms.

The relation between the increasing use of cement and the diminishing timber supply in the United States has been the subject of some correspondence between the Geological Survey and the Forest Service at Washington. In a letter to the forester, the director of the survey took occasion to quote from a statement of a large Philadelphia firm to the effect that it would be difficult to estimate what the additional drain on the lumber supply would have

been during the last few years had not cement come into such general use. The forester replied in part as follows: "The Forest Service is watching with a great deal of interest the increasing use of cement and other substitutes for wood. They are undoubtedly having some influence on the price of lumber, though I do not think that up to the present time they have greatly retarded the advance in lumber prices. The fact is that our industrial progress has been so great that our requirements for every kind of structural material have increased tremendously. We are using at the present time more lumber per capita than ever before and probably twice as much per capita as we did fifty years ago. The conclusion can not be escaped, therefore, that in the future we must depend more than in the past on other materials than wood for certain purposes at least. As to the increase that will take place in the production of cement, my impression is that this will be very great." If the increase in the use of cement in the United States in past years is to be regarded as any index to its future use, the conclusions of the forester are well founded. The statistics of the production of minerals show that our output of cement has more than doubled in the last five years, and it is well known that its use is being very widely extended. This is due to two conditions: In the first place, excellent cement materials are common in almost all sections of the country; in the second place, reinforced concrete for heavy building material is receiving increased favor among engineers, while in the country regions large amounts of cement are being used for building blocks for smaller structures. Reports received by the survey during the six years from 1902 to 1907 show that the production of cement in the United States has increased from 25,000,000 barrels, valued at approximately $25,000,000, to 51,000,000 barrels, valued at $55,000,000, the annual statistics showing a steady increase in production with some slight fluctuations in price.

THE western phosphate lands recently withdrawn from entry by the Secretary of the Interior in accordance with the President's order comprise portions of Morgan, Rich and Cache counties in Utah; portions of Bear Lake, Bannock, Bingham and Fremont counties in Idaho; and nearly all of Uinta County in Wyoming—in all about 7,500 square miles of land more or less underlain by phosphate rock and constituting the greatest known phosphate deposit of the world. Phosphoric acid is an essential constituent of productive soil. Work at agricultural experiment stations in Wisconsin, Ohio and Illinois has shown that in fifty-four years the cultivated soils of those states have been depleted of one third of their original content of phosphoric acid, or at an annual rate of about 20 pounds per acre. Even if the loss has been only one half this amount it would require 6,000,000 tons of phosphate rock annually to offset this depletion in the 400,000,000 acres of cultivated lands in the United States, without allowance for increase in the area cultivated or in the agricultural yield. The list of lands to be withdrawn was furnished by the United States Geological Survey as a result of preliminary examinations made in the field. Further work will be done by the survey as soon as practicable, for the purpose of making a careful classification of the lands and restoring to agricultural entry such portions as may contain no phosphates. It is pointed out by the survey that the situation of this western field is most favorable. The smelters at Butte and Anaconda give off gases, chiefly sulphurous, which are very injurious to vegetation. These gases can be utilized to great advantage by converting them into sulphuric acid for the manufacture of superphosphate fertilizer, thus transforming a substance that is injurious to vegetation into one that is beneficial.

A LETTER to *Nature* signed "T" reads as follows:

The council of the Chemical Society, at a recent meeting when it was determined to exclude women from the fellowship, but to admit them to the society as "subscribers," decided, "after mature deliberation"—the phrase is the senior secretary's—that the appellation "subscriber" should be printed with a big S!

Daughters of Eve! So zealous to pursue
The work in Life by which you seek to live!

When F.C.S. you claim, as is your rightful due—
The S alone is what they, grudging, give!
Be patient! Time is on your side.
Reason and justice will your cause defend.
Ignoble spite and arrogance of pride
Shall meet their retribution in the end!

UNIVERSITY AND EDUCATIONAL NEWS

Mr. George M. Laughlin, of Pittsburg, has bequeathed, in addition to $125,000 to the hospitals of the city, $100,000 to Washington and Jefferson College.

The authorities of University College, Bristol, as part of the scheme to establish a University for the West of England, have purchased the Blind Asylum and its lands, which adjoin University College.

In memory of the late Sir George Livesey, it is proposed to establish a professorship of fuel and gas engineering at Leeds University, for which purpose at least £10,000 will be collected.

Dr. F. W. Eurich has been appointed professor of forensic medicine in the University of Leeds.

Dr. Max Rubner, professor of hygiene at Berlin, will succeed Professor W. Engelmann as professor of physiology.

As successors of Professor Haeckel, at Jena, the faculty has proposed Professor Lang, of Zurich, Professor Kückenthal, of Breslau, or Professor Platte, of Berlin. It is said that Professor Platte will be selected by the administration.

DISCUSSION AND CORRESPONDENCE

LIGHTS ATTRACTING INSECTS

To the Editor of Science: In the issue of Science of December 4, 1908 (N. S., Vol. XXVIII., pp. 797, 798), Mr. Owen Bryant states certain observations and asks certain questions regarding the reaction of insects to lights from different sources. As to the relative efficiency in attracting insects of mercury vapor lights, flaming arc lights using sodium carbons, and ordinary arc lights, *when all are of the same area,* I can give no information, nor am I aware that accurate tests of this nature have been made. In a general way, however, it is probable that Mr. Bryant's view that the light of shorter wave-lengths has more effect is correct, since it has long been known that certain insects, such as ants, give little or no response to red light. This is generally true for the lower organisms, even including *Amœba.*

But Mr. Bryant has made the common mistake of considering only the intensity and quality of the lights and not taking the *area* into consideration. His observations are very similar to those of Loeb,[1] who found that a certain crepuscular moth (*Sphinx euphorbiæ*), when liberated in a room lighted on the one side by a window and on the other by a kerosene lamp, always flew to the window unless it was very close to the lamp when set free. Parker[2] made further experiments on the same phenomenon in *Vanessa,* and I have elsewhere published[3] the results of experiments on several species of insects and a number of other animals, whose reactions were tested to two lights of the same quality and equal intensity, but of different area. The general result was that positively phototropic animals possessing image-forming eyes, such as the butterflies and moths, reacted by going much more often toward the larger light. This would seem to explain the observations of Mr. Bryant in the room, and might possibly apply to some of the kinds of lamps he mentions. At any rate, it shows the necessity of keeping in mind the factor of the *size* of the sources of illumination as well as the intensity and quality of the light they give. In considering size the large globe (as in the case of the arc light) and other parts or adjacent surfaces that reflect light must be taken into account.

Leon J. Cole

[1] Loeb, J., "Der Heliotropismus der Thiere und seine Uebereinstimmung mit dem Heliotropismus der Pflanzen," Würzburg, 1890, p. 47.

[2] Parker, G. H., "The Phototropism of the Mourning-cloak Butterfly, *Vanessa antiopa* Linn.," Mark Anniversary Volume, No. 23, pp. 453–69, pl. 33, 1903.

[3] Cole, L. J., "An Experimental Study of the Image-forming Powers of Various Types of Eyes," *Proc. Amer. Acad. Arts and Sci.,* Vol. 42, No. 16, pp. 333–417, 1907.

EDUCATION AND THE TRADES

To THE EDITOR OF SCIENCE: I was much interested in the letter of Stella V. Kellerman in your issue of November 13, in relation to "Education and the Trades." Her words "Only by teaching honestly what the world needs, and can use, may the schools accomplished their lofty aims" should be taken as a motto by educational leaders and authorities the world over. I should like to ask a question which I hope some day to see answered in SCIENCE:

Suppose a poor man is enabled by close saving to send his son to a high school "to get an education." The boy does not know what he is "going to be," has no ideas of any trade, business or profession, but he wants to be "educated," and is an average student. There may be hidden in this boy a Lincoln, a Carnegie, an Edison or a Rockefeller. He may have it in him to become a book-keeper at $1,000 a year, or a good mechanic at $3 a day. No one knows. By the time he gets through high school he may have acquired the ambition to go to college, or he may be tired of school and want to "go to work" at anything that turns up. *This is the average high school boy.*

What should be the high school curriculum for such a boy? If the elective system is in vogue who shall make the election for him, and on what basis or theory shall it be made, so as *not to waste the time* of the boy while he is in the high school? WM. KENT

THE NEW YORK SERIES

To THE EDITOR OF SCIENCE: In view of the fact that my article on revision of the New York Series[1] is apparently much antedated by Dr. Grabau's paper before the New York Academy,[2] may I ask space to explain that my manuscript, exactly as printed, was submitted for publication the last of December, 1907, one week before Dr. Grabau's paper was read. A comparison of the two papers will reveal the changes necessary in my table to give proper recognition to the names introduced by Dr. Grabau, which thus acquired priority of publication. GEORGE H. CHADWICK

[1] SCIENCE, No. 715, p. 346, September 11, 1908.
[2] SCIENCE, No. 694, p. 622, April 17, 1908.

SCIENTIFIC BOOKS

A Text-book on Roads and Pavements. By FREDERCIK P. SPALDING, Professor of Civil Engineering, University of Missouri, Member American Society of Civil Engineers. Third edition, revised and enlarged. New York, John Wiley & Sons. 1908.

This book was first issued in 1894 while Professor Spalding was connected with Cornell University. A second edition was published in 1903. The many changes in methods of construction and maintenance, due in part to new traffic conditions, has made it necessary for the author to practically rewrite several chapters for this the third edition. In this, as in former editions, the author discusses the principles involved in the construction and maintenance of the various kinds of streets and roads. The first chapter, on road economics and management, contains, among other things, some interesting paragraphs on tractive resistance, in which is given a valuable table showing the relative loads a horse can draw on different kinds of roads and on grades from one to fifteen per cent. This chapter also contains articles on the economic value of better roads, sources of revenue and systems of road management. The second chapter deals with drainage of streets and roads and contains a table showing the proportions and dimensions of materials used in building reinforced concrete culverts of different sizes. This table should be of especial value to highway engineers and road builders. The third chapter relates to the location of country roads, and is treated from an engineering as well as from a practical standpoint. Chapter four, on the improvement and maintenance of country roads contains information on the building of earth roads, the use of the split-log drag, best methods of building gravel, oil, sand-clay and burnt-clay roads, and the advantages of wide tires. Broken-stone roads are considered in chapter five, which contains articles on the macadam and Telford methods of construction, rock for road building, methods for testing materials, main-

tenance of roads, bituminous macadam, etc. The theory and practise of foundations for pavements are presented in chapter six. Chapter seven relates to brick pavements, and contains complete information as to the most approved method of testing paving brick, and the construction and maintenance of brick pavements. The use of asphalts and bitumen in paving is discussed fully in chapter eight. The treatment and testing of wood blocks and the construction of streets of this material are treated in chapter nine. Chapter ten presents the most approved method of building pavements of granite and sand-stone blocks. The eleventh and last chapter presents various methods of arranging city streets so as to best accommodate the traffic. This is a practical book, and is advanced in character. On the whole the author covers his subject well. However, the first chapter could have been more complete, especially the portions relating to the economic value of good roads, cost of wagon transportation, and the benefits derived from road improvement. In the paragraphs relating to the testing of road materials, Mr. Spalding draws from what appears to be the latest published information on the subject, and fails to include a number of important improvements which have been made recently by road-material laboratories, notably the Office of Public Roads in Washington, both in testing machines and in the methods of testing road materials. The chapters on brick and bituminous pavements are probably the strongest features of the book.

ALLERTON S. CUSHMAN

SCIENTIFIC JOURNALS AND ARTICLES

The American Naturalist for December has as its first article a paper on "Some Physiological Effects of Radium Rays" by Charles S. Gager, the author concluding that, up to a certain point the effect of radium is to stimulate growth, while beyond that it causes retardation or death. W. A. Cannon discusses "The Origin of Structures in Plants" and Braxton H. Guilbeau the "Origin and Formation of the Froth in Spittle Insects." His conclusion is that this is made up from two sources; the fluid portion being the anal secretion into which air is introduced by the caudal appendages, while the mucilaginous part is secreted by the glands of Batelli. William A. Hilton has a note, with an illustration, of "Peculiar Abnormal Teeth in a Jack Rabbit"; David Starr Jordan furnishes an unusually large number of "Ichthyological Notes," relating to many papers, and H. E. Jordan gives a "Digest of C. Correns's Memoir on the Inheritance of Sex in Higher Plants." The number is accompanied by the index to Vol. XLII.

Bird-Lore for November-December has articles on "The Sea Birds' Fortress (Bird Rocks)," by A. C. Bent; "The Drumming of the Ruffed Grouse," by E. J. Sawyer, with a picture from life; "The Use of a Blind in the Study of Bird Life," by Frank M. Chapman; "A Thrasher Friend," by Emeline Maddock and the seventh paper on "The Migration of Fly-catchers," by W. W. Cooke. The number contains the Report of the Annual Meeting of the National Association (of Audubon Societies) and the Reports of State Societies. This portion of *Bird-Lore* has grown in size and importance and now constitutes one half the number.

BOTANICAL NOTES

NOTES ON RECENT GENERAL PAPERS

PROFESSOR H. M. RICHARD'S admirable lecture on "Botany" delivered in the Science, Philosophy and Art course at Columbia University is a concise answer to the questions as to the content and scope of the science of botany. Answering the question that it considers "all the questions as to the form, the functions, the classification and distribution" of plants, the author rapidly sketches the history of the science from Aristotle to Darwin in a few pages, and then discusses the present aspects of the different departments of the subject. Its reading will well repay any botanical student who wishes to be better informed as to the place that botany fills to-day in the world of science.

Here may be noted Mr. B. C. Gruenberg's thoughtful paper on "Some By-products of

Biology Teaching" in the *Proceedings* of the New York Science Teachers' Association for 1907. The writer of these notes would commend it to those young (and old) teachers of biology who think that the subject has value for its content only.

Two little pamphlets for students are Professor Wilcox's "Laboratory Guide to the Study of Elementary Botany," and Professor Clements's "Guide to the Trees and Shrubs of Minnesota." The first is evidently intended for students in such schools as can yet make only rather limited use of the compound microscope and where the laboratory work is necessarily confined to gross anatomy and simple physiological experiments. It must prove useful for the class of students for which it is intended. The second booklet (of twenty-eight pages) succeeds by means of keys and brief descriptions in making it easy for any student of botany to make out the name and relationship of any tree or shrub in the state of Minnesota. Its helpfulness for all classes of botanical students is obvious at a glance.

An instructive and helpful paper for teachers and students of botany is Professor Ramaley's paper on "The Botanical Gardens of Ceylon" in the *Popular Science Monthly* for September, 1908. Eight half-tones from photographs help the readers to obtain a better idea of the rich vegetation of the island.

While not necessarily confined to botany, Mr. O. F. Cook's paper on "Methods and Causes of Evolution"[1] contains so much that bears upon botanical problems that it should be found in every botanist's library. It is a most significant fact that this was published as a contribution to agriculture! What would the farmers just before the civil war have thought if any one had suggested that in half a century they would be practising evolution according to Darwin!

Allied to the foregoing is the same author's paper on the "Reappearance of a Primitive Character in Cotton Hybrids,"[2] giving some individual results of experiments for the purpose of acclimatizing certain weevil-resistant varieties of cotton.

In January, 1905, Captain John Donnell Smith, of Baltimore, presented his herbarium and botanical library to the Smithsonian Institution. The former, consisting of more than 100,000 specimens, became a part of the National Herbarium. Now we have a catalogue of the library of 1,600 bound volumes,[3] which will be very helpful in giving exact titles of many rare books.

CHARLES E. BESSEY

[1] Bull. 136, Bureau of Plant Industry, U. S. Dept. Agric.

[2] Circular 18, Bureau of Plant Industry.

[3] Contrib. U. S. National Herbarium, Vol. XII., Pt. 1.

SPECIAL ARTICLES

NOTE ON SOME NEW JERSEY FISHES

A YOUNG example of *Lactophrys triqueter* was taken at Grassy Sound, on September 18, 1904, and presented to me by Mr. R. M. Miller. This is the first instance of this species occurring in New Jersey waters. Dr. R. J. Phillips obtained an interesting collection at Corson's Inlet, among which were examples of *Anchovia brownii, Hyporhamphus unifasciatus, Trachinotus falcatus, Lagodon rhomboides, Bairdiella chrysura,* young *Micropogon undulatus, Stephanolepis hispidus, Myoxocephalus æneus, Rissola marginata* and *Ammodytes americanus.* The last was very abundant, and many examples of large size were found. An example of *Merluccius bilinearis* was secured at Ocean City, in Great Egg Harbor Bay, on July 26, by Mr. D. McCadden. In this connection I might mention that Mr. O. H. Brown secured an example of the four-toed salamander, *Hemidactylium scutatum,* at Cape May, on July 20, which is the first record of its occurrence in the lower half of the state.

HENRY W. FOWLER
ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA,
December 17, 1908

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES

THE academy held its annual meeting Monday evening, December 21, 1908, at the Hotel Endicott,

about seventy-five members and their friends being in attendance.

The report of the recording secretary showed that during the year 1908 the academy had held eight business meetings and twenty-eight sectional meetings, at which ninety-six stated papers and four lectures had been presented, classified under fourteen branches of science; furthermore, that four public lectures by noted home and foreign scientists had been given at the American Museum of Natural History to the members of the academy and the affiliated societies and their friends. Attention was called to the preparations under way for the celebration, on February 12, 1909, of the centenary of the birth of Charles Darwin and the semi-centennial anniversary of the appearance of "The Origin of Species," which promises to be an event of more than ordinary importance to the local scientific public. This report also stated that the membership of the academy was now 458 active members, including 127 fellows and 12 associate active members, a net loss of 42 active members during the year 1908.

According to the report of the corresponding secretary, the academy has lost by death during the past year the following honorary members: Lord Kelvin, elected in 1876; Professor Charles A. Young, elected in 1878; Professor Wolcott Gibbs, elected in 1899; Professor Wm. K. Brooks, elected in 1898; Professor Asaph Hall, elected in 1889; and the following corresponding members: Professor Daniel C. Gilman, elected in 1876; Professor Albert de Lapparent, elected in 1900; Professor Albert B. Prescott, elected in 1876; Colonel Aimé Laussedat, elected in 1890. There are now upon our rolls the names of forty-five honorary and 142 corresponding members. At the meeting three honorary members were elected, namely: Dr. Eduard Strasburger, professor of botany in the University of Bonn; Professor Kakichi Mitsukuri, director, College of Science, Imperial University, Tokyo, Japan; Dr. Wilhelm Ostwald, of the Royal Society of Natural Science, Leipzig, Germany; and the following active members were elected fellows: Dr. Charles P. Berkey and Dr. Charles L. Pollard.

The treasurer's report showed that the financial condition of the academy was satisfactory.

The officers of the academy desire to call the attention of the members to the fact that the academy has in its keeping two important funds, the income of which is available for the encouragement of scientific research. These are the Esther Herrman Building Fund and the John Strong Newberry Fund. Grants are made to members of the academy or of the affiliated societies upon application to the council of the academy with the endorsement by the society of which the applicant is a member. During the past year more than one thousand dollars was paid out from the Esther Herrman Research Fund on account of such applications, and the reports presented by the grantees show the importance of the assistance granted. Income is now available for appropriation upon approved application.

The librarian's report showed that during the past year the library of the academy has received through exchange and donation 454 volumes, 32 separata and 1,863 numbers. The chief accessions were a gift of 40 volumes from La Société des Naturalistes de Varsovie and of 71 volumes from the Sociedad de Geographia, Lisbon. The books may be consulted by members and the public any week day between the hours of 9:30 A.M. and 5 P.M., and members are urged to assist in extending the use of the library.

According to the editor's report, part 3 completing volume XVII. was distributed early in the year and parts 1 and 2 of volume XVIII. have been printed and distributed, while two parts of part 3 of volume XVIII. have been printed but not distributed. Part 1 of the latter volume was devoted to the records of the Linnæus celebration of May 23, 1907, including the addresses delivered on the occasion and the greetings received from sister organizations at home and abroad.

The annual election resulted in the choice of the following officers for the year 1909:

President—Charles F. Cox.

Vice-presidents—J. J. Stevenson, Frank M. Chapman, D. W. Hering and Maurice Fishberg.

Recording Secretary—Edmund Otis Hovey.

Corresponding Secretary—Hermon Carey Bumpus.

Treasurer—Emerson McMillin.

Librarian—Ralph W. Tower.

Editor—Edmund Otis Hovey.

Councilors (three years)—Franz Boas, Henry E. Crampton.

Finance Committee—Charles F. Cox, George F. Kunz and Frederic S. Lee.

After the business meeting, the members of the academy and their friends sat down together at the annual dinner, at the conclusion of which the president, Mr. Charles F. Cox, gave an address upon "Charles Darwin and the Mutation Theory."

E. O. Hovey,
Recording Secretary